

THE HISTORY OF GALVESTON'S CONCRETE SHIPS

A Thesis

by

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ABSTRACT

Selma is one of three World War I concrete shipwrecks in the Galveston area. While the other two are not identified, one of them is likely the *Durham*. This research explores how and why these ships ended their service here, and looks at the different methods used for the creation of early concrete ships and the differences in their performance.

Selma, one of twelve Emergency Fleet Corporation ships, had a much different design than *Durham*, but both of the ships were out of use quickly after launch. *Selma* ran aground and damaged its bow; it was subsequently taken to Galveston for repairs that never occurred. *Durham* proved to be a very poor sailor, but remained afloat for many more years before becoming a fishing pier in Galveston. Both of these ships have histories of re-use that last beyond their abandonment.

This research focuses on the history and construction of *Selma* and *Durham*. The text discusses the developments that lead to the development of these ships and how they fared after construction. Additionally, visual survey of how the condition of *Selma* has changed over time is included.

DEDICATION

This thesis is dedicated to my parents. My father who always encourages and believes in me, and my mother who was always supportive and inspiring.

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The survey data in Chapter 4 was collected with the help of the Texas Historical Commission, Amy Borgens, and Sarah Linden.

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CHAPTER I

INTRODUCTION

Along the path of the Galveston-Bolivar Ferry route in Galveston, Texas there is an unusual sight: a concrete ship is sticking out of the water. While this ship, *SS Selma*, is the most visible and most famous, it is in fact one of three concrete shipwrecks in the Galveston area. All three are partially exposed above the water, but only Selma has been positively identified. The smallest wreck is located off Bolivar peninsula in the Gulf of Mexico near Bolivar Flats and the third wreck is located near the end of the Port Bolivar's north jetty. *SS Durham* is a likely candidate for the identity of one of the unidentified wrecks, but there is no record confirming which wreck it may be.

Both *Selma* and *Durham* date to World War I and have unique stories that highlight the struggle to adapt new construction materials and methods to combat the wartime shortage of merchant ships. Concrete ships were created to provide a quicker and cheaper way to resupply and expand the merchant fleet during World War I. As with any new technology or method, different approaches were attempted to reach the same result. Concrete ships were no exception. The basic objectives and ideas behind each of the concrete ships were the same as with other materials; cost, efficiency, speed of construction, and sufficient internal reinforcement to provide strength.

Although oceangoing concrete ships were a new concept, the use of concrete for marine purposes was not a new idea. Small concrete barges and boats had been used in Europe and the United States since 1887. The technique used to build them had been

around for almost forty years from the building of the first concrete boat but was mostly ignored in favor of iron and steel until necessity created a demand. Both *Selma* and *Durham* were believed to be ships that would help concrete emerge as a viable and possibly even favored method of ship construction.

This thesis will research the history and construction of these ships. While these vessels were built for similar reasons, their construction and history vary greatly. The current and past condition of the hulls as shipwrecks will also be compared in a visual survey using photos from various time periods.

CHAPTER II

HISTORY

Beginnings of Concrete Ships

The earliest forms of concrete watercraft were ferrocement boats. The genesis of these boats started in 1848 when Joseph Louis Lambot, a French inventor, created ferciment, an early form of ferrocement. Ferrocement is made by applying mortar or plaster around an internal support structure of metal rods and mesh. It is the added reinforcement of the continuous mesh that separates ferrocement from standard reinforced concrete.



Figure 1. First concrete rowboat made by Joseph Lambot. Reprinted from “Concrete Ships: historical notes concerning them and a discussion of the problems involved in their construction.”¹

¹ Paul Kircher, “Concrete Ships: historical notes concerning them and a discussion of the problems involved in their construction.” (Unpublished Masters thesis University of Illinois, 1918), 7.

Two of his early creations with ferrocement were rowboats (Figure 1), which he used on his pond and one of which he exhibited at the 1855 World's Fair in Paris, France. He built the boat using internal reinforcement of iron bars covered with one layer of iron mesh to create the shape. In 1855, he applied for a patent for ferrocement describing it as "a new product which helps to replace timber where it is endangered by wetness, as in wood flooring, water containers, plant pots, etc."² Along with the patent, Lambot also produced a pamphlet naming seven qualities of his new product. These qualities included "1. Non-inflammable. 2. Cheap to use. 3. Requires no upkeep. 4. Quick to build in. 5. Easily repaired in the event of damage. 6. Chemically stable. 7. Impervious to water."³ Lambot was one of many inventors and engineers working with various iterations of early reinforced concrete, but his method was the first and "fundamentally similar" to the technique in general use worldwide for the construction of various concrete vessels.⁴ These boats were made to last as his 1855 rowboat was reported to still be useable at the start of World War I.⁵ One is still displayed at the Museum of Brignolais. Lambot's invention did not create a building technique that was immediately adopted, but set the stage for the ships that were to come.

² Gaius W. Jackson, Jr and W. Morley Sutherland, *Concrete Boatbuilding* (London, 1969), 28.

³ Ibid, 29.

⁴ Ibid.

⁵ "Ships of Stone," *Scientific American*, CXIX, No. 9 (August 1918), 165.

Early concrete ships in Europe

Following the creation of concrete small boats, there was a lull before the concept started to spread. In 1887, a small barge, *Zeeneuw*, was built in Holland by the Picha-Stevens brothers and the idea of concrete boats started to spread across Europe. Holland's canals became the home of many concrete barges ranging from fifty to sixty tons. Along with Holland, the nations of Italy, Germany, Netherlands, Panama, Australia, and the United States all started to build concrete boats. These vessels were fairly small and used for inland waterways, many of them being barges that ranged from a capacity of fifteen tons to 500 tons. One of the traits that made concrete barges desirable and popular was durability.

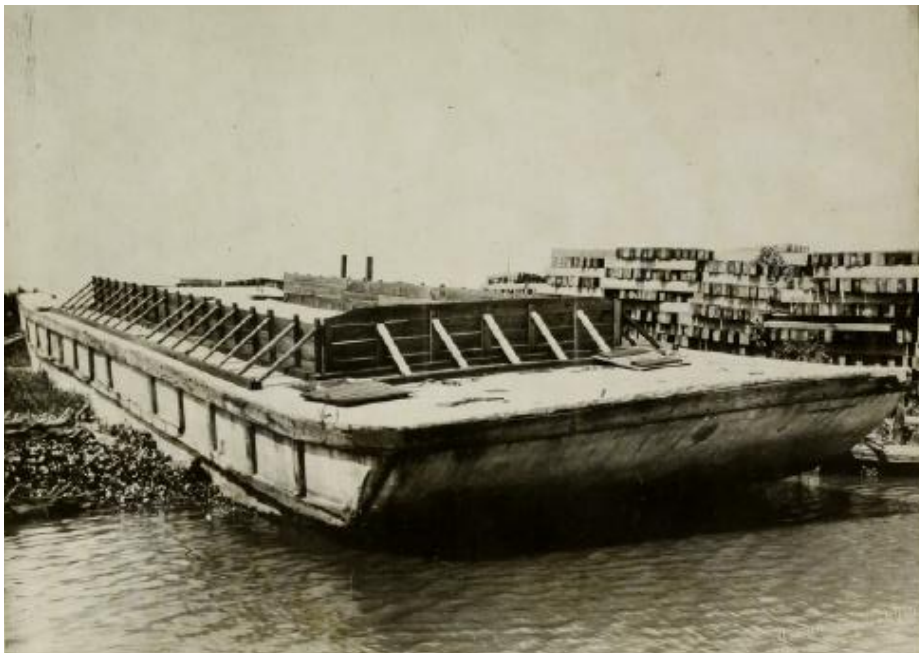


Figure 2. Ninety-foot barge built in Mobile from 1912. Reprinted from “Concrete Ships: historical notes concerning them and a discussion of the problems involved in their construction.”⁶

⁶ Paul Kircher, “Concrete Ships: historical notes concerning them and a discussion of the problems involved in their construction.” (Unpublished Master’s thesis University of Illinois, 1918), 13.

The barge built by the Picha-Stevens brothers in Holland was “reported to have encountered a number of severe collisions with larger vessels, and many times it has been frozen in the ice all winter; yet it proved unusually stable and durable.”⁷ An American barge made in Mobile, Alabama in 1912 was in service until it got caught in a 1916 storm and one side was punctured; in 1918, as the need for ships and the interest in concrete grew, the barge was repaired quickly and returned to service. There are many other examples of the durability of concrete barges that helped to make them popular in the early 1900s especially since they were also cheap to build. Some of these barges were even used in the war effort: the Italian army relied on concrete barges along the Piave River to transport its heavy guns for operations against the Austrians.⁸ Even with all the advances made in the area of concrete boats, it was not until late in World War I with the shortage of steel encouraged the pouring of the first seagoing concrete ships.

The first self-propelled concrete ship for ocean use was *Namsenfjord*, a Norwegian ship launched in 1917. This ship was built and designed by N.K. Fougner, who then built four more. Due to widespread skepticism by engineers and sailors that a concrete ship would actually work, the Norwegian government had him make it using his own money and required a sea trial before they would allow it to be used for trade or sold. After the success of the first ship, the government allowed him to build more, but once again he had to front the capital to make the ships. Following the launching of the

⁷ “Ships of Stone,” *Scientific American*, CXIX, No. 9 (August 1918), 165.

⁸ “Ships of Stone,” *Scientific American*, CXIX, No. 9 (August 1918), 179.

fifth ship, they were given provisional classification by Lloyd's Register.⁹ This classification was chosen due to the lack of examples and knowledge of the ships. In 1918, the United Kingdom launched *Armistice*, a 1,150-ton cargo carrier, to help with their war effort. It was built in the same style as the Norwegian ships, and "the Managers say that she has been running since March 1919 like a clock, causing no trouble, disappointment, delay or difficulty."¹⁰ The operating costs of *Armistice* were also reported to be well below those of a steel ship, but the building cost was very expensive.

The first oceangoing concrete ship constructed in the United States was *Faith*, launched in May 1918 by the San Francisco Shipbuilders Company. *Faith* was followed by the concrete ships of the Emergency Fleet Corporation (E.F.C.) and other private companies. *Faith* was considered to be 'hastily built' but was believed to have carried more cargo and sailed more distance than any of the later ships. This vessel had an advantage when compared to other concrete ships because it was quickly built and ready as the demand for shipping hit its peak.¹¹ *Faith* was built very quickly after the United States entered World War I in April 1917 and its service took place during a time when any and all ships were being put into use. In comparison, other American concrete ships, government and private, were not ready until the war was either over, or almost over. *Faith's* voyages included trips along the west coast of the United States, Hawaii, the east coast of the United States, Great Britain, the Mediterranean, and South America. It was

⁹ Jean Haviland, "American Concrete Steamers of the First and Second World Wars," *American Neptune*, XX (July 1962), 158.

¹⁰ N.K. Fougner, *Seagoing and other concrete ships* (London, 1922), 189.

¹¹ Jean Haviland, "American Concrete Steamers of the First and Second World Wars," *American Neptune*, XX (July 1962), 165.

the first concrete ship to make a trans-Atlantic voyage. *Faith* completed its final voyage in 1921, unable to compete with the speed and operating costs of steel vessels. The ship was stripped of its machinery and sunk as a breakwater off Cuba. *Faith* proved that concrete was a shipbuilding method that could create ships effectively if they could be built at the right time.

Emergency Fleet Corporation

As World War I and German U-boat attacks began to take their toll on the ships of the allies, countries started to look for quick and cheap methods to replace the merchant ships that were being destroyed by the war. Due to a shortage of supplies, a variety of alternative materials were investigated to help create new ships. As *Scientific American* described it in a 1918 article, “the urgent cry for ships and more ships has compelled us to seek every means of supplementing the supply of older and better-known shipbuilding materials.”¹² The United States Shipping Board (U.S.S.B.) was established by the Shipping Act of 1916 to resolve this problem for the U.S. This act also “gave the government the power to build and operate ships during the existing emergency, and up to five years after its conclusion.”¹³ When the United States entered the war in April 1917, the United States Shipping Board created the Emergency Fleet Corporation (E.F.C.) to construct and acquire existing vessels. These two programs had a poor start with the program heads having two very different ideas on how they should be run.

¹² “Ships of Stone,” *Scientific American*, CXIX, No. 9 (August 1918), 165.

¹³ Salvatore R. Mercogliano, “The Shipping Act of 1916 and Emergency Fleet Corporation: America Builds, Requisitions, and Seizes a Merchant Fleet Second to None,” *The Northern Mariner*, XXVI, No. 4 (October 2016), 408.

E.F.C. progress was further hindered by an approval process that required the agreement of both heads before work could be done. After this inauspicious start, both programs received new leaders who compromised to have a clear vision going forward. Edward Hurley became the new head of the United States Shipping Board. Hurley quickly identified five actions to provide the necessary ships:

First, the Shipping Board would commandeer all the ships, over 2,500 tons, under construction in United States ports. Second, they would requisition all necessary ships flying the American flag. Next, they would repair, refurbish, and recondition the suitable captured German ships for use as troop transports and cargo vessels. Fourth, they would solicit neutral and allied states for additional tonnage, to supplement those ships requisitioned. Finally, the U.S.S.B. and E.F.C. would initiate a building program for wood, steel, concrete, and composite ships to provide 15 million tons in addition to the 3.5 million tons in operation when the United States declared War.¹⁴

Starting in July 1917, the U.S.S.B. followed the steps identified, with diplomatic struggles occurring along the way. The Board quickly discovered the challenges of building new ships in a hurry. With all the current shipyards already in the process of building more ships, expansion of current yards and constructing new yards was the only way to produce the needed tonnage. Part of this initiative was the construction of four steel prefabrication yards, five concrete yards, along with a revival of wood construction.¹⁵ The concrete shipbuilding program was the last to begin as yards had to be built. Yards for building concrete ships were established all over the country including the east, west, and gulf coasts. Although there was a basic template for the yards to follow, shipyards were allowed to make changes as long as they did not

¹⁴ Salvatore R. Mercogliano, "The Shipping Act of 1916 and Emergency Fleet Corporation: America Builds, Requisitions, and Seizes a Merchant Fleet Second to None," *The Northern Mariner*, XXVI, No. 4 (October 2016), 410.

¹⁵ Ibid, 418.

significantly alter the budget or timeline. This lack of standardization was likely a factor in the U.S.S.B. ships being quickly set aside in the post-war trade. Of the ships built, twelve were made of concrete. Forty-two concrete vessels were originally ordered by the E.F.C., but the end of the war terminated the program after only twelve of them were built.

The first two concrete ships made by the E.F.C., *Atlantus* and *Polias*, were experimental vessels constructed in private yards. The other concrete ships constructed by the E.F.C. were all produced in yards owned by the Emergency Fleet Corporation. The yards were designed specially for the type of ship (wood, steel or concrete), to be built at each location. Two basic types of concrete ships were created by the E.F.C.: cargo transports and oil tankers. The early ships were 3,500 dead weight tons, but this size was soon considered too small and the remaining ships were increased to 7,500 tons.¹⁶ At Wilmington, North Carolina, the Liberty Shipbuilding Co., which built *Atlantus*, also built *Cape Fear* and *Sapona* (both of the 3,500-ton variety). The upgrade to the 7,500-ton ships delayed the building program for the remaining 38 ships, and thus most were never created.

In Mobile, Alabama, Fred T. Lay and Co., Inc., of Boston, Massachusetts built *Selma* and *Lantham*. On the west coast, Pacific Marine Construction Co. built the *Cuyamaca* and *San Pasqual* in San Diego and the San Francisco Shipbuilding Co. constructed *Palo Alto* and *Peralta* in Oakland, California. Finally, in Jacksonville,

¹⁶ Jean Haviland, "American Concrete Steamers of the First and Second World Wars," *American Neptune*, XX (July 1962), 161.

Florida, A. Bently and Sons Co. of Toledo, Ohio built *Dinsmore* and *Moffitt*. Although the hulls for *Dinsmore* and *Moffitt* were finished, it is unlikely they were ever fitted with engines since they were not completed until 1921, well after World War I was over. It is important to note that while private companies were contracted to actually build the ships, each of these shipyards was government owned. The first of these ships (*Atlantus*) was completed in 1918 and the last (*Moffitt*) was completed in 1921. None of them ever made the contribution they were supposed to because none were ready in time. Other concrete ships were under construction but were sold along with the shipyards. All twelve of the completed ships were used to some extent after their launch for different purposes with varying levels of success. Some actually participated in trade, others were never more than floating storage tanks or breakwaters.

The overall success of the U.S.S.B. is a question that was raised following the end of the war. Senator William H. King of Utah stated his unfavorable opinion of the U.S.S.B., saying “the board had spent \$3,700,000,000 and all it had to show for it was seven valueless concrete ships, 300 useless wooden ships, and 1,400 steel vessels of doubtful value, half of which are tied up and out of service.”¹⁷ The wooden vessels from the program were mostly made with green, unseasoned wood, causing them to be leaky. The steel vessels from the program were often of lower quality than other steel ships made available by the ending of the war. The concrete ships were slower and had less stowage capacity than steel ships of comparable size. Proponents of concrete looked at these vessels as a start to new methods in the future, something that could be improved

¹⁷ “The Shipping Board’s Task,” *The Brownsville Daily Herald*, 23 June 1921.

upon as new techniques and mixes of concrete were created. In the end, the concrete ships did not achieve their potential as only twelve of the forty-two were completed before the end of the war. They were never tested in World War I and had no chance to make a difference in the shipping shortages.

SS Selma

Although *Selma* was built to help the merchant fleet in World War I, it was not launched until 28 June 1919. This was the same day as the signing of the Treaty of Versailles which formally ended the war. The front page of the *Mobile News-Item* had the announcement of the launching of *Selma* surrounded by articles announcing peace.¹⁸ Other dates have been reported as the launch date, depending on the source it has been listed from as early as 20 June to as late as 30 June 1919. As noted earlier, the hull was built by the firm Fred T. Lay and Co., Inc. of Boston, Massachusetts in an E.F.C. shipyard in Mobile, Alabama. The ship was 434 feet (132.28 meters) in length and fifty-four feet (16.46 meters) in beam. *Selma* was the first of the E.F.C. ships to be moved up to the 7,500-ton size which caused a delay in its building. This delay was only one of the struggles that affected the building of *Selma*. Contrary to the hopes of the U.S.S.B., the dead weight ton price for *Selma* was around \$282 and the total hull cost was \$786,754, which was comparable to a steel ship.¹⁹

¹⁸ "7500-ton Steamer is Now Ready to be put Overboard with a Crowd of Over 2000 Attending," The Mobile News-Item, 28 June 1919.

¹⁹ Jean Haviland, "American Concrete Steamers of the First and Second World Wars," *American Neptune*, XX (July 1962), 165.

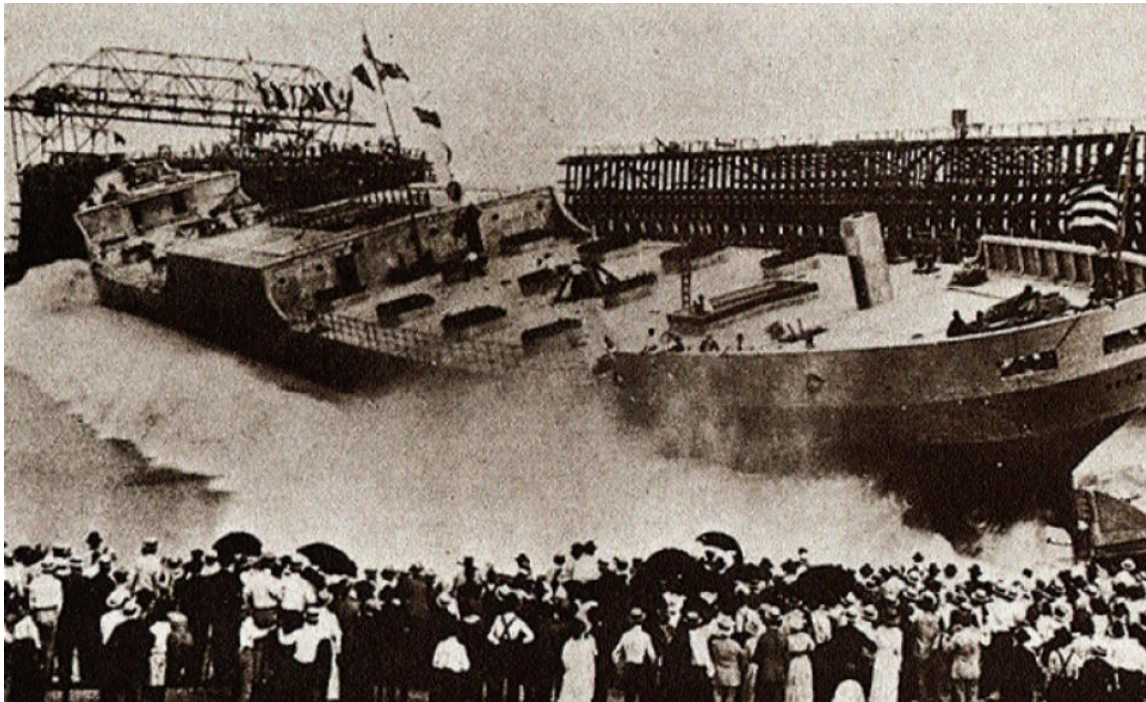


Figure 3. SS *Selma* being launched in Mobile, Alabama. Reprinted from *Aberdeen's Concrete Construction*.²⁰

Selma was the largest ship to be launched sideways on the Gulf Coast (Figure 3), and some spectators questioned how the ship would handle it.²¹ Their worries were unnecessary as *Selma* was launched without issue.

After outfitting, the ship was employed as an oil tanker. It set out in April 1920 on a “smooth as glass seas” on its maiden voyage to Tampico, Mexico. After arriving it loaded a cargo of 38,000 barrels of crude oil to deliver to the United States. Because of heavy traffic in the area, on 16 May, *Selma* moved out of the port and anchored just

²⁰ R.W. Steiger, “Going to Sea in Concrete,” *Aberdeen's Concrete Construction*, XXXVII, No. 6 (June 1992), 472.

²¹ “7500-ton Steamer is Now Ready to be put Overboard with a Crowd of Over 2000 Attending,” *The Mobile News-Item*, 28 June 1919.

outside the jetties at the mouth of the Panuco River. This area was considered extremely hazardous as it had conflicting currents from the river and the Gulf of Mexico. Not only were the currents dangerous, the jetties themselves were not well maintained, and were described as “in several places submerged and scattered over the floor of the entrance to the harbor.”



Figure 4. View of *Selma* stranded on the Tampico jetty from the deck of the SS *John D. Rockefeller*. Reprinted with permission from The Mariners' Museum.²²

When *Selma* raised anchor in rough weather on 17 May to complete loading, the currents pushed it onto the jetty near another vessel that had been stuck on the jetty for over six months (Figure 4). *The Galveston Daily News* described the aftermath of the wrecking:

²² The Mariners' Museum, photography collection, APB1 V71, 29 November 2018.

Effort to back off the jetty proved unsuccessful, and the grinding of the rocks against the forepart of the hull of the vessel soon tore a sixty-foot [18.28 meters] hole in the bottom from the sixteen-foot [4.88 meter] waterline down. The forward deck was awash, and where soundings were taken about two minutes after the vessel ran on the rocks the forepeak tank had filled with water, and ten minutes after striking, the dry cargo holds forward of the bridge had filled. With her bottom ripped out, she lay on the rocks while the seas, continually washing over her as far as No. 2 tank, sprayed her superstructure, masts, etc. with the oil set adrift from the front cargo compartments. All the cargo except about 14,000 barrels stowed in the after tanks was liberated.²³

Tampico was a common place for ships to wreck. Besides the ship stranded on the jetty when *Selma* wrecked, its sister ship, *Lantham*, also ran into a jetty at Tampico on 15 July 1919.²⁴

To get *Selma* back to the United States, compressed air was continuously pumped into the forward cargo space. Since the bottom of the hull in this area was missing, heavy timbers were attached to side of the vessel. “Immense A frames of heavy wooden spars were built, and these were placed at about fifteen-foot [4.57 meter] intervals along the top of the deck [Figure 5].²⁵

²³ “Coming from Rocks at Mouth of Tampico Harbor, the First Concrete Ship Enters Port,” The Galveston Daily News, 29 August 1920.

²⁴ “Repairs to Bottom Stand Test, Engineers Says,” The Galveston Daily News, 20 October, 1920.

²⁵ “Coming from Rocks at Mouth of Tampico Harbor, the First Concrete Ship Enters Port,” The Galveston Daily News, 29 August 1920.

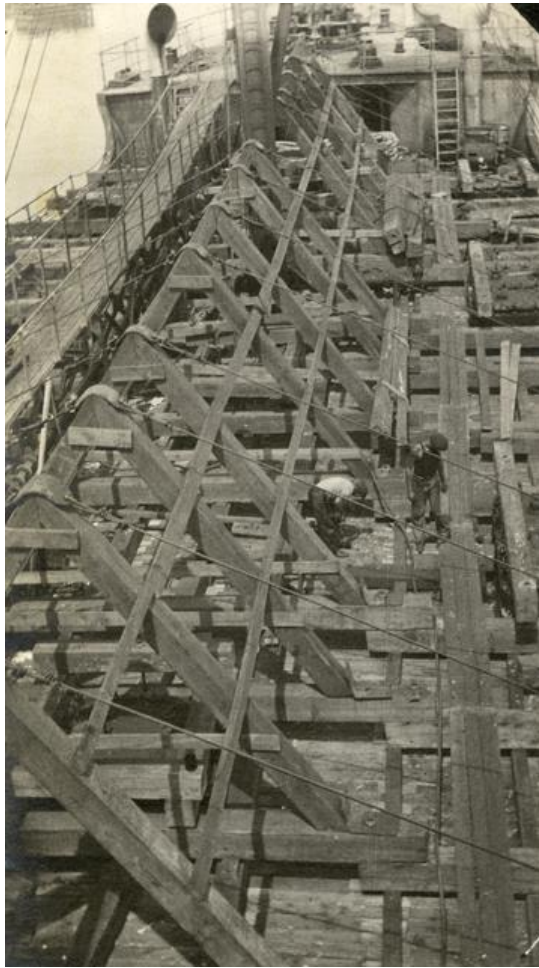


Figure 5. Reinforcing timbers on *Selma* to allow it to be sailed to Galveston. Reprinted with permission from The Mariners' Museum.²⁶

These were secured to the timbers on the side of *Selma*, the ship was sailed to the United States. *Selma* reached Galveston, Texas for repairs on 15 August 1920. The vessel returned under its own power, running both the engines and generators non-stop. It was reported that the paint in the engine room was burned off from the heat. For this trip to

²⁶ The Mariners' Museum, photography collection, APB1 V71, 29 November 2018.

Galveston, *Selma* did not have a full crew of forty-three men but instead had a skeleton crew (only three of whom were on board when it hit the jetty). Most notable of this crew was First Officer E.R. Dibel. According to the *Galveston Daily News*, Dibel

was serving as a member of the naval intelligence department in the shipyard where the *Selma* was built and saw the keel of the ship laid...he was asked to occupy an officer's berth on the tanker and because he had seen her in the course of her building and because his curiosity was aroused over the possibility of sailing on a concrete vessel, he accepted, and, as he says now 'has been with her through all of her troubles.'²⁷

Selma's entry into Galveston was followed by the sister ship, *Lantham* a few days later. Repairs were expected to happen in that order, but none of the Galveston shipyards had ever seen or dealt with a concrete ship before, let alone two requiring repairs. The American expert in concrete shipbuilding, Walter R. Harper, was sent to Galveston to oversee the repairs. Harper needed to remove the broken concrete, straighten the reinforcing steel, and get the new concrete to bond with the old while also keeping the contour lines.²⁸

In October 1920, *Selma* was advertised for sale, with the requirement that bids include \$38,000 for the repair materials already shipped to Galveston.²⁹ The request for bids was still open in December of the same year, but no longer required covering the repair costs. This later advertisement included *Latham*, describing its condition as "has

²⁷ "Coming from Rocks at Mouth of Tampico Harbor, the First Concrete Ship Enters Port," *The Galveston Daily News*, 29 August 1920.

²⁸ "Repairs to Bottom of Concrete Vessel Stand Test, Engineer Says," *The Galveston Daily News*, 26 October 1920.

²⁹ "United States Shipping Board: Concrete Tankers for Sale," *New-York Tribune*, 15 October 1920.

just completed alterations designed for its betterment and is ready for immediate delivery.”³⁰ *Lantham*’s repairs had been completed by October.

Although materials were shipped to Galveston, *Selma* was never actually repaired. A report on *Selma* stated that restoring the vessel to seaworthy condition “seemed to be impracticable. It was too badly damaged to make it serviceable again and too costly to break up.”³¹ A major part of the problem was the reinforcing steel jutting from the damaged area of the hull, to the extent that there was no smooth surface for the ship to sit on during its time in dry dock. While awaiting repairs or a buyer at Pier 10, the ship sank in the dock.³² Removing the ship from here was the first step in what became a prolonged scuttling process. Compressors were employed to keep air pressure in the hold and raise the vessel from the mud. In most ships, the engine equipment and other items would be taken out and salvaged, but it was “not considered likely that much of the *Selma*’s engines or other machinery will be salvaged. The major items of the engine room are set in the concrete from which the hull is cast.”³³ The expense of recovering the engines could not be recouped, so the preparation of the hull for abandonment focused on easily removed items such as furnishings, planking and electrical fittings. Prior to raising the ship one last time to move and scuttle, a permanent location first had to be chosen. Different areas were considered, including outside the south jetty, or moving the ship to another port entirely, but the location ultimately

³⁰ “United States Shipping Board: Concrete Tankers for Sale,” *New-York Tribune*, 15 December 1920.

³¹ “To Make Concrete Ship into Pier,” *The San Antonio Evening News*, 2 March 1922.

³² “Concrete Ship is Nearing it’s End,” *The Galveston Daily News*, 15 January 1922.

³³ *Ibid.*

chosen was Pelican Flats - a shallow area near Pelican Island. A 1500 foot (457 meter) long and 25 feet (7.62 meter) deep channel was dredged to ensure *Selma* was far enough from the main channel to not impede shipping traffic.³⁴ *Selma* refloated and then scuttled in this location on 10 March 1922.

The many newspaper and journal articles written about the early days of *Selma*, contain numerous errors and omissions. One area of discrepancies is the question of how long *Selma* was in service. Some articles say the Tampico wrecking was on the maiden voyage, while others say *Selma* had a few successful trips, and still others say it was in use for three years before sinking. Based on the known dates of major events, it is clear *Selma* wrecked in its first year. The launch was in June 1919 and it arrived in Galveston for repairs on 15 August 1920 after the May wrecking, so the ship was in service for less than a year. A few trips may have been made, but an article from *The Galveston Daily News*, dated 29 August 1920, describes the wreck as occurring on the maiden voyage.³⁵ Regardless of which voyage saw *Selma* meet its end, the results remain the same, a shallow water grave in Galveston Bay.

Far from the ship's history being over following the abandonment, the story of *Selma* was just beginning. When plans for scuttling and abandonment were first coming out, newspapers reported that the hull might be turned into a "pleasure pier" as Galveston had given a proposal to the U.S.S.B. once it became clear the previous plans

³⁴ "Concrete Tanker Finally Sent to Grave in Channel," *The Houston Post*, 11 March 1922.

³⁵ "Coming from Rocks at Mouth of Tampico Harbor, the First Concrete Ship Enters Port," *The Galveston Daily News*, 29 August 1920.

for repairing or breaking up the ship were too expensive.³⁶ The “pleasure pier” plan was never implemented. Instead, after the scuttling, *Selma* was sold by the US Shipping Board for \$1000 to J.E. Peterson and J.L. Bludworth. With most of the ship still above the water, it was reported the buyers planned to convert the hull into a fishing resort. Peterson subsequently bought out Bludworth for \$500, then he eventually sold it to Henry G. Dalehite in 1929. Unfortunately, not everyone was happy about the addition of *Selma* to the Galveston waterfront. In 1928, while the hulk was being used by the Oil Exploration Company as a base of operations and storage for prospecting work, an article in *The Galveston Daily News* stated that *Selma* “is an eyesore and distinctly a bad advertisement for the city” and suggested that “an organized effort to blow her up should be made.”³⁷ The prominent location alongside the ship channel, clearly visible on the ferry route and from the most eastern end of the seawall, ensured that a large number of people saw the hulk.

In July 1928, a reward was placed in the newspaper by J.E. Peterson “for information leading to the arrest of persons destroying deckhouses on concrete ship *Selma*.”³⁸ No information was given in the papers as to whether the vandals were ever caught. As successive post-scuttling ventures failed to work out or even start, *Selma* became a repository of sorts. During Prohibition, U.S. Customs officers broke 2,000

³⁶ “To Make Concrete Ship into Pier,” *The San Antonio Evening News*, 2 March 1922.

³⁷ “Suggestion for Accidental Explosion of Dynamite on Selma is Advanced Locally,” *The Galveston Daily News*, 9 September 1928.

³⁸ “Notices,” *The Galveston Daily News*, 25 July 1928.

cases of liquor on the deck, disposing of the illegal liquor through the scuppers and tossing the broken bottles into the hull.³⁹

Selma changed hands again, bought by Clesmey 'Frenchy' LeBlanc in 1946 for 100 dollars from Henry Dalehite. Frenchy moved out to the vessel and quickly became one of its most fantastical stories. While using the vessel as his home he "never bothered about taxes, food, high rent, women or many of the other perplexing problems that harass the mind of the average man in modern civilization."⁴⁰ One of the most notable events that happened during LeBlanc's sojourn on the ship was the First National Convention of the Happy Hermits, Inc. It was open to anyone who wanted to participate and took place out on the ship. Planned by representatives from Fox Movietone and Universal News, the hermits were provided with signs with slogans such as "we want women members" and "Civilization? We'll stay in Galveston Channel."⁴¹ During his time on the ship, LeBlanc even brought along some chickens and a goat, and only moved off the ship when failing health forced him to find lodging ashore.

Continuing the tradition of using *Selma* as a dumping ground for illegal diversions, in 1957 Texas Rangers dumped 2,000 slot machines alongside the hull after the shutdown of the Maceo family gambling parlors. Supposedly, in the days directly following the dumping by the Rangers, people called in reports of the slot machines floating in the Galveston and Houston Shipping Channels (this was later proved to be

³⁹ "Last of Liquor is Consigned to Sea," *The Galveston Daily News*, 6 October 1926.

⁴⁰ "Story of Old Concrete Ship Landmark Intrigues New Galveston Generation," *The Galveston Daily News*, 8 July 1962.

⁴¹ "Civilization? Bah! Hermits Give Preference to Galveston," *The Galveston Daily News*, 19 February 1948.

false). An effort was made by treasure hunter Carroll Lewis in 1994 to recover the slot machines (which he valued to around \$3 million based on a value of \$1,500 each). He was not expecting to find money in the slot machines but based the value strictly on the machines themselves.⁴² Lewis clearly underestimated the effects of salt-water corrosion on delicate mechanisms. No follow up article has been found to indicate if the slot machines were ever located and recovered.⁴³

After Frenchy LeBlanc sold *Selma*, the deteriorating hull went through multiple owners before being before being bought by a man who was fascinated by its history. Pat A. Daniels was part of the Historical Association of Houston when the opportunity to purchase *Selma* arose in 1992. Daniels acquired *Selma* and created the Pat A. Daniels and *Selma* LLC to help distance him from any liability related to ownership of the decaying structure. He also invited his friend William Cox to buy shares and become a partial owner. Daniels fought for recognition of *Selma* on both the state and national level and his efforts were rewarded in 1993 with *Selma* being recognized with a state of Texas Historical Marker, and in 1994, when the hull was added to the National Register of Historic Places. *Selma* was also given the honor in 1993 of being named the flagship of a ceremonial commemorative group, the Texas Army. Daniels passed his love of *Selma* on to friends, and a yearly birthday celebration for *Selma* is now held in Galveston by the SS *Selma* Association. Although Daniels died in 2011, the celebration

⁴² “Bay Hides Trove of One-Armed Bandits No Longer,” *The Galveston Daily News*, 29 October 1994.

⁴³ Ken Cox, Pers. Comm. Current owner Ken Cox, whose father was on the expedition with Lewis said the weather was bad when they went out and as far as he knows “none of the slot machines were ever recovered.”

is still taking place, with the latest occurring on 19 May 2018. A 100-year anniversary party is planned for May 2019. The event is now hosted by current owners Ken and Bonnie Cox, who inherited *Selma* from Ken's father, William Cox.

Other Concrete Ships and Shipwrecks

About 170 miles (273 kilometers) southwest of Galveston, in Aransas Pass, Texas, a private shipyard was built by the France and Canada Oil Transport Company in 1918. The company decided to make experimental oil tankers based on a new design created by R.A. Durham and commonly referred to as a 'whale backed tanker'. The unusual hulls were based on the theory that, because they were built out of concrete, many of the ship design considerations that might apply to other materials did not apply to them. The ships were made of two large cylindrical tubes connected in Venn diagram fashion (Figure 6). Concrete slabs connected the two cylinders on the top to make the deck, and below to make the bottom of the ship. When under construction they were described as resembling "nothing so much as silos, or small concrete grain elevators, similar to those seen at flour mills and were often mistaken for such when viewed from the harbor some little distance away."⁴⁴ The ships were 2,000 tons, had a length of 298 feet (90.83 meters) and a beam of 33 feet 9 inches (10.29 meters). The vessels were made by the McDonald Engineering Corporation with the aid of a government subsidy during World War I to help replenish the fleet of available ships. Beyond their

⁴⁴ "Construction of Concrete Ships of Texas Ports Meeting with Success," The Galveston Daily News, 24 October 1920.

interesting construction, these ships were also a boon for the community as the shipyard brought employment to the area. The company complained “that unless something was done to house the families of the 600 workmen that they would lose them as employment was so plentiful all over the country.”⁴⁵ The ships were named after two company officers. *Durham* was launched on 24 July 1920, and *Darlington* was launched 15 November 1920.⁴⁶

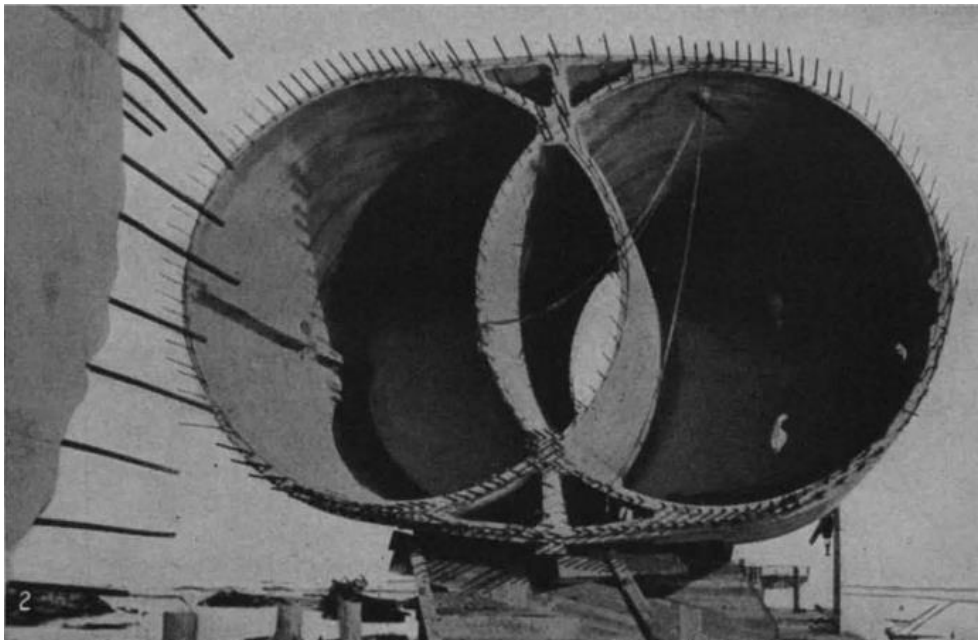


Figure 6. Hull portion of SS *Durham* or *Darlington*. Reprinted from *Scientific American*.⁴⁷

⁴⁵ “Industrialist Describes War-Time Expansion: Concrete Ships Gave Employment to 600 Men,” *The Aransas Pass Progress*, 2 September 1937.

⁴⁶ “Concrete Oil Ship to be Launched at Pass on November 15,” *The San Antonio Evening News*, 11 November 1920.

⁴⁷ Ralph Howard, “A Daring Ship Design,” *Scientific American*, CXXIV, No. 4 (January 1921).

These ships were originally designed to trade between Tampico, Mexico and Port Aransas carrying oil, but after one trip *Durham* was “proven unsatisfactory as to seaworthiness.”⁴⁸ W.A. Schrivner worked at the shipyard in Aransas Pass, and in the 1970s shared his experiences with *The Aransas Pass Progress*, including a description of the first trip of what he remembered to be *Darlington*. One of the crew, H.L. “Sleepy” Bedwell gave this account of the voyage to his friend W.A. Schrivner:

He said that the gulf was not rough at all, but on account of the round shape of the ship and with so little keel to it, the ship simply wallowed around and was very unwieldy, making the time for the trip about three times [longer than] what another steel tanker would take. “Sleepy” said it was impossible to steer the ship past the jetties protecting the harbor, and the bow simply nosed onto the rocks and subsequent waves pushed it farther up. The crew was lucky to get off without injury.⁴⁹

It is important to note that this account may have been exaggerated over time as it was recorded around fifty years after the events occurred and was a second-hand account.

Another account by Bedwell, this time in a letter to Galveston newspaper reporter Alan Castleschouldt, gives a slightly different version of events:

In the early 20’s a company called The France and Canada Steamship Company came to Aransas Pass to build two experimental concrete ships... They bought three ocean-going tow-boats. One of these tugs attempted to take an oil barge out into the jetties and sunk about a mile south of the south jetty.

I was working in the machine shop as a machinist helper while these boats were being built. They finally got the *Durham* fitted out. She was powered by a 160 H.P. diesel motor which was about one third of the power that was needed. The machine foreman knew I had quite a bit of oilfield experience firing oilfield boilers. One day he came to me and said ‘come with me’. We went over the *Durham* and he told the chief engineer that I was taking charge

⁴⁸ “Concrete Tanker Strands on Beach: Uncompleted Vessel from Port Aransas Aground at Pass Cavallo,” *The Galveston Daily News*, 21 June 1922.

⁴⁹ “Rebuilding Aransas Pass after the 1919 hurricane part of Kelley career,” *The Aransas Pass Progress*, 23 September 1970.

of the boiler room. There was no one there who knew anything about boilers so I got along fine.

After so many days we finally went to sea. The ship was almost round—no keel. It rolled so much the sailors had to tie themselves down in order to stay in bed. It was 360 miles from the bar at Port Aransas to the bar at Tampico. We must have covered 450 miles to get there on account of not having enough power to steer. When we got in the Panuco River in Tampico there was a 5-6 knot current in the river so we laid in the river until they sent a tug from Port Aransas to dock us. After we loaded and got back out to sea that ship was as sluggish as a water-logged tree, no movement whatsoever. I was discharged the morning after we docked at Port Aransas. I heard later they had made a barge of her. Her sister ship was named *Darlington*. She never went outside until they attempted to tow her to Galveston. I was told she broke the towline. She went on the beach at the north end of Matagorda Island. I do not know why *Durham* was sunk at Bolivar Roads.⁵⁰

There are some discrepancies between the two accounts. The first difference in the Bedwell-Schriener account is that it says *Darlington* went on the voyage and *Durham* was never finished. In fact, according to newspaper accounts at the time, *Durham* was the only one to attempt a voyage to Tampico and *Darlington* was never finished. Therefore, in this account the Bedwell letter was correct. The other discrepancy with the Bedwell-Schriener account is that it states that the vessel was never recovered and “as I heard...it was finally pounded to pieces on the jetties.”⁵¹ Both *Darlington* and *Durham* were sold and had final resting places far from Aransas Pass as stated in the later Bedwell letter and confirmed by newspapers, but as stated in the beginning of the Bedwell letter, there was a tug that was sunk on the jetties. The variances between the two accounts can probably be explained by one being a firsthand memory while the other is a secondhand memory. Both versions agree that the ships were not good sailors.

⁵⁰ Letter from Bedwell to Castlenboaldt, Rosenberg Library, Galveston and Texas History Center, Vertical Files D, Circa 1880-2018, *Durham* (Concrete ship), 14 July, 2018.

⁵¹ “Rebuilding Aransas Pass after the 1919 hurricane part of Kelley career,” *The Aransas Pass Progress*, 23 September 1970.

Durham and *Darlington* were sold along with three barges and two steel tugs in an auction on 11 March 1922 to settle a lien.⁵² Both of the ships were bought by the Callahan-Atkinson Company out of New York along with two of the barges for \$5000.⁵³ On 16 June 1922 they were in tow from Port Aransas to Beaumont, Texas (along with a barge), when a squall came up. The line parted between *Durham*, the first in the line of ships being towed, and *Darlington*, the second. There were no men aboard *Darlington*, only in the third vessel, the barge. Men aboard the barge set an anchor and tried to keep the two ships steady, but the line between *Darlington* and the barge also parted. *Darlington* quickly ran aground.⁵⁴ *Darlington* was never fully finished after the failure of *Durham*'s first trip, and the company's plan for the two concrete vessels was "to tie them up in the river above Beaumont for the time being hoping ultimately to dispose of them in some manner."⁵⁵ Not surprisingly, the grounded *Darlington* was never recovered by its new owners. It can still be found in Matagorda Bay, near Corpus Christi where it sank in 1922. While the hull is not as visible in the water as *Selma*, it has been spotted during low tides. *Darlington* is still a fixture in the fishing community and appears on message boards as a good fishing spot.

Following the ill-fated tow to Beaumont, *Durham* was tied in the river near a drawbridge type railroad bridge owned by the Kansas City Southern Railroad Company. In 1924, the railroad company tried to have *Durham* moved from the area due to the

⁵² "Tugs and Barges to be Sold Here on Saturday," *The Galveston Daily News*, 10 March 1922.

⁵³ "Concrete Tanker Strands on Beach: Uncompleted Vessel from Port Aransas Aground at Pass Cavallo," *The Galveston Daily News*, 21 June 1922.

⁵⁴ Ibid.

⁵⁵ Ibid.

navigational risk it created. Their claim stated that if the Neches River rose high enough and *Durham* broke free, it would run into the railroad bridge. In order to force the owners to move their hulk, Kansas City Southern had to show proof that *Durham* posed a menace to navigation.⁵⁶ While there was no reported verdict in the case, it is clear that Kansas City Southern was unsuccessful, for on 28 February 1932, the *Port Arthur News* reported a collision between *Durham* and a tug with a barge just upriver of the railroad bridge. The bridge was delayed in rising for the oncoming tug because a train was coming, and when the tug with the barge lost their headway they drifted into *Durham*.⁵⁷ No damage was reported. It is never stated what *Durham* was used for, but not long after this accident it was moved again.

The *Del Rio Evening News* from 26 March 1935 related that *Durham* was purchased to use as a chemical plant by the Seaboard Tankers Corporation and the Seaboard Oil Company of Houston for “one-fiftieth of her original cost to the government.”⁵⁸ It is after this that the history of *Durham* becomes murkier. The last mention in newspapers is in September 1935 when the *El Paso Herald-Post* reported the hull was moved that month to Galveston, to be placed alongside Pelican Spit and used for storage purposes by the oil company.⁵⁹ A 1984 issue of *In Between Magazine* (a defunct Galveston magazine), reported that William D. McMillian Sr. obtained the rights

⁵⁶ “K.C.S. Claims Concrete Ship to be a Menace,” *The Port Arthur News*, 4 May 1924.

⁵⁷ “Tug and Barge Hit Vessel – No Damage,” *The Port Arthur News*, 20 February 1932.

⁵⁸ “Concrete Ship to be used as Chemical Plant,” *Del Rio Evening News*, 28 March 1935. The article does not state how they planned to use the hull as a chemical plant. It is likely that additional structures would be built on the deck to convert the ship as was done with one of the E.F.C. concrete ships, *Peralta*, that was used as a fish processing plant.

⁵⁹ “Concrete Ship Moved,” *El Paso Herald-Post*, 9 September 1935.

to *Durham* in 1936 and had it towed to Galveston for use as a fishing pier. Called Sportsman's Pier, it was in business until it was destroyed by a hurricane.⁶⁰ Another article in the same magazine described its final resting place as "near the North Jetty of Point Bolivar."⁶¹ Sportsman's Pier is mentioned in *The Galveston Daily News* multiple times from 1937 to 1940, but no article could be found on the opening and subsequent destruction of Sportsman's Pier, or the final resting place of *Durham*.

Although there is not a recorded final location for *Durham* in Galveston, there is also no record of the ship ever leaving the area. It would also have been difficult to move *Durham* if it was sunk for use as a fishing pier. This makes the Galveston area the likely location of the shipwreck, and considering there are two unidentified concrete shipwrecks in the area this possibility is increased.



Figure 7. Concrete wreck off Bolivar peninsula. Reprinted with permission of Corpus Christi Public Libraries.⁶²

⁶⁰ Alan Castleschouldt, "The Concrete Dream," *In Between Magazine*, November 1984.

⁶¹ John Davenport, "Concrete History, The Selma," *In Between Magazine*, November 1984.

⁶² Corpus Christi Public Libraries Archive, General Photograph Collection, Collection F1 Box 18 Folder 18.04, 14 August, 2018.

There is evidence to support both of the unidentified shipwrecks as *Durham*. Photos of the smaller unidentified concrete wreck off Bolivar Flats, labeled as the *Durham*, can be found at the Corpus Christi Public Library. The construction of this ship does appear to match the construction of the ships built at Aransas Pass. However,



Figure 8. Concrete wreck off the north jetty. Reprinted with permission of Corpus Christi Public Libraries.

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at around 100 feet (30.48 meters) long, the length of this wreck is slightly over a third of the known length of the vessels built at Aransas Pass, so it is possible this is only a portion of the ship. It is important to note that these pictures do not have any provenience or date associated with them.

The second unidentified wreck at the end of the north jetty is in the correct position for *Durham*. It is also shown in photos at the Corpus Christi Public Library

⁶³ Ibid.

(Figure 8), but they are labeled *Darlington*. Since *Darlington* wrecked off Matagorda Island in an area with no jetties, the label is clearly incorrect. The photo being labeled as *Darlington* may point to this ship also being of the whale-backed construction. This wreck is recorded on the 1940 NOAA charts, which eliminates the many barges that were later wrecked on the jetty. This second wreck might also be *Durham*. While an exact length has not been recorded, a rough estimate from a Google Earth satellite image shows that it is about 213 feet (64.92 meters) in length - very close to two-thirds of *Durham*'s full length. This could point to both of these wrecks being *Durham* in two pieces. The question then becomes how the sections ended up over two nautical miles (185.2 km) apart.

Conclusion

The struggles of World War I created an environment where concrete ships became desirable and practical. The end of the war and the surplus of merchant ships changed these imperatives, and concrete ships ceased to be built. The few ships that were completed were briefly used in various trades until they were accidentally sunk or intentionally scuttled. The post-war abundance of steel vessels meant that slower, harder to build, and less efficient concrete vessels became disadvantageous. Concrete never reached its potential as a building material that was touted in the early and enthusiastic predictions. This manner of building was ignored until World War II created another sudden demand for ships. The two World War I ships off of Galveston were scuttled for different reasons that both equaled a lack of usefulness. *Selma* was too complicated and

expensive to fix, while the second one (most likely *Durham*) was scuttled because it performed poorly as a tanker vessel.

The eventful post-sinking careers of these ships is probably the most surprising aspect of their history. Far from disappearing from view, both hulls became popular fishing spots after they sank. For *Selma*, scuttling was the beginning of a wide range of stories and legends that captured the imaginations of people over the years. The vessel's presence in Galveston has made it a cultural and historical landmark. The less-visible *Durham* does not have the same Galveston legends attached to it but has still managed to make an impact on the local fishing community.

CHAPTER III

CONSTRUCTION OF WORLD WAR I CONCRETE SHIPS

Construction of Earliest Concrete Vessels

The first ferrocement rowboat was built in France by Joseph Louis Lambot in 1848. To create the desired shape, Lambot made a frame of iron bars covered with a layer of wire mesh.⁶⁴ The basic construction of the concrete rowboat was later modified in many ways to create increasingly larger vessels, culminating in the oceangoing ships of World War I.

The two most important aspects of a concrete hull are the inner framework and the concrete itself. The concrete must be made of aggregates that ensure the hull is waterproof when the vessel dries. Along with the types of particles, the amount of water used in mixing the concrete also played an important role that was not realized until later. Early ferrocement builders were unaware that the strength and durability of mortars was significantly reduced by increasing the water content. Luckily, the mortar could easily be worked into the mesh with a small amount of water being added. Another critical aspect of concrete mix was the size of the different aggregates. This idea was better understood, and a size of below approximately 3mm was identified as necessary to allow for the correct penetration and compaction.⁶⁵ Lambot's boat was the first, but almost forty years later, other boat builders started using concrete. The ideal

⁶⁴ R.G. Morgan, "Development of the concrete hull," *Concrete Afloat* (London, 1977), 3.

⁶⁵ Ibid, 5.

water-cement ratio was not fully developed until much later, and when the World War I concrete ships were built the recognition that the ratio of water to cement changed the quality of the final product was just taking hold.⁶⁶

In 1887, the first reinforced-concrete barge was built in Holland. The early “reinforced” vessels of this type relied on a frame consisting only of steel bars. The lack of expanded mesh in the internal reinforcement made them more prone to cracking and more likely to develop large cracks at lower load levels. Ferrocement was preferred in many cases since reinforced concrete had a lower tolerance for stresses and cracking. Once cracks opened, the interior reinforcement was susceptible to corrosion.⁶⁷ From Holland, the use of concrete barges spread through many western European countries in the early years of the 20th-century.

It was in Norway in 1917 that the first seagoing concrete ship was built, a 200-ton vessel intended to carry cargos between Norway and England. The designer, N.K. Fougner, had experience building concrete lighters at Manila in the Philippine Islands, and in 1912 filed his first patents in the United Kingdom for a seagoing concrete ship. It was not until 1916, however that Fougner took the plans for one of his ships to the Norwegian Department of Shipping for approval. The government stalled, granting a permit but noting that its “naval architects, concrete engineers, and sailors expressed their unreserved opinions...that the whole idea was impossible and that a *seagoing*

⁶⁶ “Story of the Selma,” Expanded Shale, Clay and Slate Institute (June 1960), 11.

⁶⁷ R.G. Morgan, “Development of the concrete hull,” *Concrete Afloat* (London, 1977), 6.

concrete ship was doomed to disaster the first time she encountered rough weather.”⁶⁸

After failing to secure outside support, Fougner used his own company to pay for building *Namsenffjord*. The vessel had an overall length of eighty-four feet (25.6 meters) with a breadth of twenty feet (6.1 meters) and (as noted above) a cargo capacity of about 200 tons. For propulsion, it was outfitted with a Bolinder crude oil engine capable of 80 horsepower with a designed speed of 7 ½ miles per hour (12.07 kilometers per hour).

The construction of *Namsenffjord* was unique, for instead of having a wooden form it was built using a perforated metal lath for most of the large sections. Wood centering was used for the frames and deck beams, and wooden boxes for frames and beams helped to stiffen and support the metal lath. For the main structural support there was metal mesh by each portion of vertical plating with reinforcing rods tied to the mesh. The concrete was poured between the mesh and vertical plating. It was finished with a cement mortar on the two surfaces.⁶⁹ All of the steel reinforcement for the hull and deck was in place before the concrete was poured. Internal walls and bulkheads were constructed afterwards by metal mesh with round bars serving as additional horizontal and vertical reinforcements that were then plastered with concrete mortar.

One of the biggest areas of concern when building the ship was the engine foundations along with the sternpost and rudder. How the ship would react to the stress of vibrations from the engine influenced the design of these elements. It was believed that a concrete hull would distribute less of the engine vibration than a steel hull and

⁶⁸ N.K. Fougner, *Seagoing and other concrete ships* (London, 1922), 7-8.

⁶⁹ *Ibid*, 11.

localize areas of stress on the hull. If this had not been incorrect, the result could have been devastating due. To help combat this possible problem, a foundation made of two heavy girders running parallel to the centerline and connected to five transverse frames was created to distribute the engine vibrations over both the frames and bottom slab. For the sternpost, a concrete internal post was included when building the hull. A wrought-iron post with the structural hardware needed for the propeller and rudder was secured to the sternpost with seventeen anchor bolts. This post was further supported with eight inch (20.32 centimeter) wide steel plates used to enclose the end of the concrete.⁷⁰ Both of these design features were found to be successful for the operational lifetime of the vessel.

Other materials were employed, for the finishing features. Wood was used for the deckhouses and many other internal structures, such as the oak used for the fenders and bilge keels. Steel beams were used to protect the hatch coamings from chipping. Finally, a 5-horsepower winch and other standard equipment for similar merchant vessels were fitted. Following the addition of these components, the ship was ready to be launched. After two failed attempts to get it off the ways, a floating crane was brought in and *Namsenfjord* finally reached the water 2 August 1917. The launch was followed by the installation of machinery and a round of sea trials. These were deemed to be successful and by the end of the month the ship loaded its first cargo.

This early concrete hulled-merchant ship was considered a success but had design issues that affected how future concrete ships were built. The first

⁷⁰ N.K. Fougner, *Seagoing and other concrete ships* (London, 1922), 14.

recommendation was for wooden deckhouses to have concrete walls to ensure a proper joint. Another recommendation was for the main hatch to have rounded corners: squared corners were to be avoided in the concrete construction to avoid introducing stress concentrations. The double mesh walls were seen as being overbuilt and only one layer of mesh recommended for future ships. Another design feature that was deemed to be an overdesign was the double bottom, as it added weight and interfered with inspections and piping.

The most important feature to be addressed in future ships was the inclusion of gravel in the concrete. It was a desirable addition to the mix for level areas where concrete would be poured, as concrete with gravel was cheaper and may have been less prone to cracking, but in vertical areas, it was found to cause problems with the mortar attaching to the reinforcement. *Namsenfjord* was the start of larger, seagoing concrete ships, and the lessons learned during its construction and sea trials were used to improve subsequent vessels. N.K. Fougner constructed four more concrete vessels in Norway after the success of this venture and also advised the U.S.S.B. on the E.F.C. concrete ships.

The earliest concrete ship in the United States, *Faith*, was built in 1918 by a private company, the San Francisco Shipbuilding Co., in Redwood City, California. When it was completed, it was the largest concrete ship in the world with a length of 320 feet (97.54 meters) and a breadth of forty-four feet, six inches (13.56 meters). *Faith* had a registered capacity of 4,500 tons though the hull was designed to carry 5,000 tons. It was a screw steamer with triple expansion engines that produced 1,700 horsepower and

a top speed of around ten knots (18.5 kilometers per hour). *Faith* was launched six weeks after San Francisco Shipbuilding started pouring concrete. This quick completion gave credence to the idea that if there was a design and shipyards to build them, then concrete ships could be the answer to any shortages of merchant vessels. For its construction, heavy transverse frames had a spacing of sixteen feet (4.88 meters) with longitudinal framing. To help ensure the strongest bond between the concrete and steel, deformed bars with projections were used. There were seven watertight concrete bulkheads. The thickness of the concrete ranged from four to four and a half inches (10.16 to 11.43cm) on the sides and bottom and three to three and a half inches (7.62 to 8.89cm) on the shelter deck. Not all of the ship was concrete as the main, poop, bridge, and forecastle decks, and ceiling planking in the cargo holds were all constructed from wood.⁷¹ *Faith* ended up costing \$750,000, well above the original estimate of \$300,000 to \$400,000.

Although the budget was a disappointment, *Faith* performed well in other areas. The hull was watertight with no sweating in the holds, and “in rough seas...exhibited the easy movements and lack of machinery vibration which are characteristic of concrete ships.”⁷² Perhaps most importantly, *Faith* traded for many years successfully and was the first concrete ship to cross the Atlantic.

Construction of the Emergency Fleet Corporation

⁷¹ Jean Haviland, “American Concrete Steamers of the First and Second World Wars,” *American Neptune*, XX (July 1962), 159.

⁷² N.K. Fougner, *Seagoing and other concrete ships* (London, 1922), 70.

Construction of the Emergency Fleet Corporation

The vessels of the Emergency Fleet Corporation (E.F.C.) were started with the building of two experimental vessels, *Polias* and *Atlantus*. Both were built in private yards by two different companies. The other ten concrete ships built by the E.F.C. were built in five

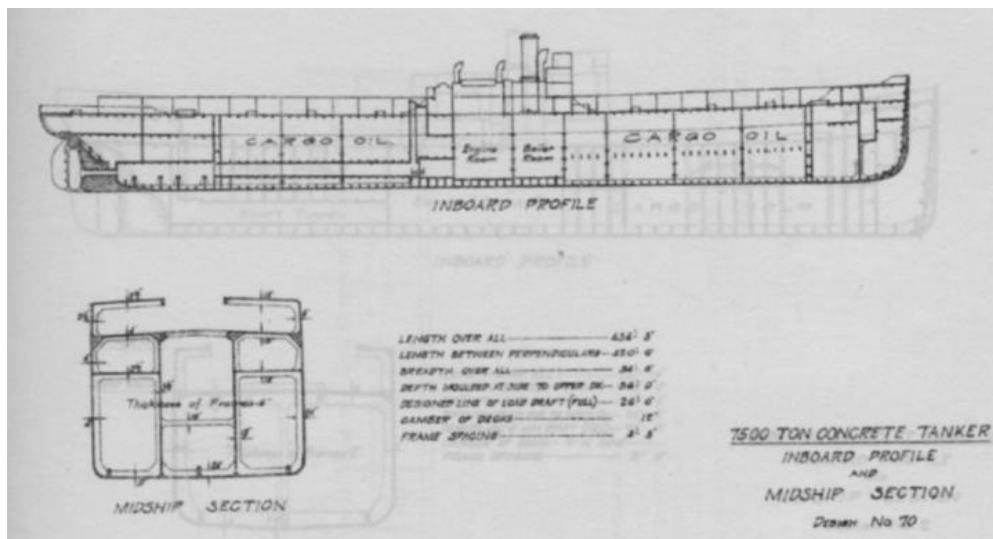


Figure 9. Design of 7,500 ton concrete tankers. Reprinted from *Society of Naval Architects and Marine Engineers*.⁷³

government owned shipyards by companies contracted for the work, though the original goal was for each of the shipyards to produce eight ships. Each yard was given the same set of guidelines for building the ships, but also give autonomy to modify how the ship was built and what materials were used as long as it did not cause too much of a schedule delay or price increase. The hulls were originally designed to be 3,500-ton ships, but after building the first two, it was determined this design was too small to be

⁷³ R.J. Wig, Esq., "Method of Construction of Concrete Ships," *Society of Naval Architects and Marine Engineers*, XXVII (November 1919), 8.

practical. It was determined that the rest of the ships would be built to a 7,500-ton deadweight capacity.

Two designs were used, one for a cargo ship and the other for an oil tanker. The order of the construction process is not exact because different stages often overlapped and the availability or lack of required materials determined the sequence.⁷⁴ The basic building process, not accounting for the differences of each yard, was as follows:

1. The supports for the forms are constructed followed by the erection of the outer form.
2. Steel inserts (i.e. pipes, stem plate) that need to be in place before the concrete is poured are secured to the forms.
3. Reinforcing steel for the hull and frames is assembled in the outer forms along with the splice bar connecting the hull and bulkheads.
4. The inner form is built to four or five feet (1.22 or 1.52 meters) and concrete is poured to the top of the inner form.
5. The inside form is removed and the top surface of the concrete is prepared for the next pour.
6. This basic process with adjustments is repeated for the rest of the ship until the concrete is all in place.

⁷⁴ R.J. Wig, Esq., "Method of Construction of Concrete Ships," *Society of Naval Architects and Marine Engineers*, XXVII (November 1919), 2.

7. The inner and outer forms are removed and the concrete is cleaned. It is then tested up to the draught line & patching is done as needed. After all the issues are resolved the hull is painted.
8. The ship is launched.⁷⁵

Since each shipyard had some degree of autonomy on how they built the ships many of the techniques of the building process varied.

Forms for concrete ships were required to be more exacting than regular concrete forms since an irregularity could affect the safety and cost of a ship. The design tried to limit the weight of the hull while still being able to contain the steel reinforcements and meet the requirements for strength and capacity. Extra weight, inadequate cover and/or space for the steel, and nonuniform surfaces were all problems that could be created by poorly prepared forms.⁷⁶ The outside forms were supported by scaffolding of wooden trestles at regular intervals. To ensure that the forms were aligned to create the correct hull lines, frame templates were made in combination with prefabricated panels. The preferred wood for the outside form in eastern shipyards was cypress because it was unlikely to warp when exposed to the elements for long periods of time. One crucial feature of the forms was how well they stayed in position. To ensure the outer form would not move with the vibrations of the air hammer, outer forms were bolted to the inner form or by tying both inner and outer forms to the reinforcing steel.

⁷⁵ R.J. Wig, Esq., "Method of Construction of Concrete Ships," *Society of Naval Architects and Marine Engineers*, XXVII (November 1919), 2-3. For the full description of the construction sequence see Appendix B.

⁷⁶ Ibid, 5.

Another challenging aspect when pouring the concrete was to account for all the inserts. The inserts were all of the metal fittings that needed to be secured in position before the concrete was added.⁷⁷ The necessary fittings varied greatly in size from small inserts for items like anchor bolts and pipe sleeves to large inserts for the stern post and stem plate. The inserts were usually placed on the forms immediately after they were built, before the reinforcing steel was attached. This strategy did not always work as many of the cast items such as bollards were not drilled precisely, so anchor bolts did not match the corresponding holes on the cast items.⁷⁸ Luckily this problem was easily solved as holes could easily be drilled into the concrete.

The use of structural high-grade steel was originally planned for these ships, but due to wartime demand for premium steel, there was not enough available. Instead, the reinforcing steel was made from the discarded croppings of shell ingots. This variety of steel is much harder than structural grade steel with a yield point of about 60,000 pounds per square inch (413,685,420 Pa) being about 10,000 pounds per square inch (68,947,570 Pa) more than structural grade steel. The ultimate tensile strength of the reinforcing steel was about 95,000 pounds per square inch (655,001,915 Pa), which was 15,000 pounds per square inch (103,421,355 Pa) more than the structural grade steel. This steel was harder to bend into the necessary shape, and for every 7,500-ton concrete

⁷⁷ R.J. Wig, Esq., "Method of Construction of Concrete Ships," *Society of Naval Architects and Marine Engineers*, XXVII (November 1919), 8.

⁷⁸ *Ibid*, 9.

ship, approximately 1,600 short tons were used. The steel was made into round bars ranging from 3/8 inch (0.95 cm) to 1 3/8 (3.49 cm) inches diameter.⁷⁹

A few concrete ships were end launched, including *Faith*, but with the ships becoming much larger, there was concern for how much strain the concrete could take. To avoid the possibility of crippling a brand-new ship, it was determined that sideways launches were the best course of action.

Under normal circumstances a ship lying in the water is supported uniformly at all points; even when the water is moderately rough the condition is seldom departed from materially. But as she stands on the ways before launching, she is supported only at isolated points, and her hull must be rigid enough to bridge the gaps between these points without suffering permanent deflection...If we are building a concrete ship just as a sort of engineering pastime...we can afford to determine its resistance to vertical distortion by trying to break it or bend it; if we succeed in doing either we have proved something...as a business proposition, we cannot afford to satisfy our curiosity by this empirical process of subjecting them to strains which they will never again be called upon to meet, simply for the sake of knowing whether we can break them in two by trying hard enough.⁸⁰

The ships created by the E.F.C. had a mixed success rate. Most were completed after the war was over, so there was an overabundance of ships, making concrete an unpopular option. Steel ships were faster, often carried more cargo, and there were a large number of them available. Another factor working against these particular concrete ships is the suspicion that they were overbuilt, and that with slight adjustments a huge amount of materials and money could have been saved. One area where this was probably true was in the framing. If a five-foot (1.52m) spacing had been used instead of

⁷⁹ Gainor W. Jackson, Jr. And W. Morley Sutherland, *Concrete Boatbuilding*, (London 1969), 91.

⁸⁰ "The Marine use of Concrete," *Scientific American*, CXVIII, No. 4 (January 1918) 94.

a four-foot (1.22m) spacing, the ships would have been about 400 tons lighter.⁸¹ Along with reducing the weight of the concrete, less reinforcing steel would have been needed. Both reductions would have increased the deadweight carrying capacity.

There were benefits, though less tangible, derived from the E.F.C. program, namely that the ships made huge advances in concrete shipbuilding and in the use of concrete itself. The ships actually engaged in cargo shipping performed well, and there were even successful repairs made to one, proving that repairs were a viable option for concrete ships. Additionally, concrete ship hulls did make excellent if expensive floating storage tanks or breakwaters. E.F.C. concrete ships served in both of these capacities following World War I.

Construction of the *Selma*

Selma was one of the products of the E.F.C. concrete ship program, and was the first one built in the larger size: instead of a 3,500-ton vessel like the previous ones, it was decided to build a vessel of 7,500 tons. She was 434 feet (132.28m) long with a beam of fifty-four feet (16.46m) and a loaded displacement of 13,000 tons. *Selma* was powered by a 2,800-horsepower triple expansion engine that gave it a top speed of ten and a half knots (19.45 kph).⁸² Unlike the standard concrete of the European ships, a lightweight concrete made of expanded shale aggregate was used for *Selma's* construction.

⁸¹ N.K. Fougner, *Seagoing and other concrete ships* (London, 1922), 77.

⁸² R.W. Steiger, "Going to Sea in Concrete," *Aberdeen's Concrete Construction*, XXXVII, No. 6 (June 1992), 472.

Selma was built using a few variations of the basic E.F.C. construction method. For the blocking and cribbing, the Mobile yard used heavy timbers at all stages of support. Also different from any of the other yards, in the blocking at the Mobile yard “the girders are placed longitudinally and for the joists athwartships.”⁸³

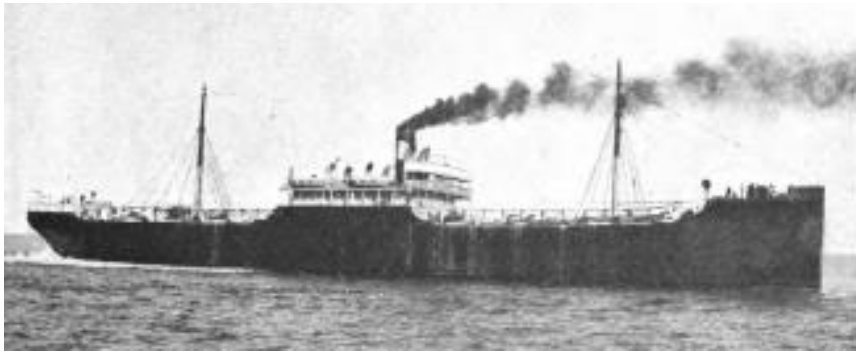


Figure 10. *Selma* at sea. Reprinted from *Seagoing and other concrete ships*.⁸⁴

The building of *Selma* was the first time a concrete ship of this size was attempted. Getting the proper placement of concrete was challenging, and to ensure that the concrete spread throughout the reinforcing steel it was mixed to be low viscosity. The engineers struggled to produce batches of uniformly mixed concrete to ensure proper placement. To combat the problem one of the engineers, Herbert A. Davis, filled a six by twelve inch (15.24 by 30.48 cm) cylinder mold with concrete and raised it on

⁸³ R.J. Wig, Esq., “Method of Construction of Concrete Ships,” *Society of Naval Architects and Marine Engineers*, XXVII (November 1919), 5.

⁸⁴ N.K. Fougner, *Seagoing and other concrete ships* (London, 1922).

fixed vertical tracks.⁸⁵ This removed the concrete from the cylinder and it would sag. The sagging was then measured and used to determine how consistent each batch was. This same technique was later refined into the modern slump cone test. This was the first time that the uniformity of concrete was tested in the field.

Serving as an oil tanker, *Selma* did not last long due to wrecking on the jetties in Tampico, Mexico, but it allowed advancements in concrete ship construction. Its building allowed for new methods and types of concrete to be used to make a ship, and after the sinking the hull was studied to learn more about the properties of concrete in seawater. In the 1950s, the use of expanded shale lightweight aggregate as a building material had increased nationwide. It was often found to be more practical due to the economic advantages and could be made high-strength. Some questioned whether this material was suitable for coastal structures. To answer the question, *Selma* was investigated in July 1953 to see how both the concrete and the steel reinforcement held up against weather and time. The Expanded Shale, Clay and Slate Institute hired the Engineers Testing Laboratory, Inc. (E.T.L.) of Houston, Texas to take samples from the hull and compartment ribs and inspected the state of the reinforcing steel and the overall state of the concrete.⁸⁶ E.T.L. engineers took concrete samples both above and below the waterline. The concrete was found to be in good condition by the visual survey and when chiseled out to a depth of ¼ inch (0.635 cm) the interior concrete was found to be

⁸⁵ R.W. Steiger, "Going to Sea in Concrete," *Aberdeen's Concrete Construction*, XXXVII, No. 6 (June 1992), 472.

⁸⁶ "Story of the Selma," Expanded Shale, Clay and Slate Institute (June 1960), 7.

dry and without discoloration.⁸⁷ The reinforcing steel was found to be “in excellent condition with no pitting of the bars...the slight coating of rust could well have been on the bars when they were placed.”⁸⁸ This was in spite of the fact that in there was only 5/8 inches (1.59 cm) of concrete over the steel in many areas. Tests of compressive strength and bond failure proved that the concrete in *Selma* was still structurally sound. The study gave the concrete industry valuable information about the longevity of expanded shale structural concrete in a coastal setting.

Durham and Darlington

The concrete vessels constructed in Aransas Pass, Texas, *Durham* and *Darlington*, represented a completely different construction approach. Originally planned as tow barges, before construction they were changed to motored vessels. The design consisted of two large concrete pipes joined in intersecting circles, connected by flat slabs top and bottom to create the bottom and deck with bow and stern sections added on. This design was based on the concept that due to the unique nature of concrete building using forms, there were more streamlined shapes that could be used to replace traditional ship lines.⁸⁹ These ships were designed to carry 14,000 barrels of oil and had a full length of 298 feet (90.83m) and a beam of thirty-three feet nine inches (10.29m).

A different process was used to construct the concrete hulls at the Aransas Pass yard. Rather than making a large form to pour concrete for the entire ship, these ships were made in a stern section, a bow section and five cylindrical thirty-foot (9.14m)

⁸⁷ Ibid.

⁸⁸ Ibid.

⁸⁹ Hal W. Hunt, “Seagoing Concrete,” *Scientific American*, CLXIX, No. 5 (November 1943), 205.

midship sections for each ship. Each section was built using sliding forms in a vertical position. The forms were continuously raised by jacks to ensure each section was free of joint lines.⁹⁰ This construction technique had not been used in concrete ships before but was often used for grain elevators. Thin sheet steel and wood made up the interior form with the steel bars for reinforcing secured to the outside. The outer form was then fitted around the reinforcing steel creating a thickness of about twelve or fourteen inches (30.38 to 35.56cm).⁹¹ After each section was completed, it was jacked onto a steel cart on railroad tracks that would allow it to be moved to the tilting cradle. From there the section would be turned to a horizontal position. The now horizontal piece was then be moved into its place in the ship. To join the different sections of the ship together, longitudinal reinforcement bars projected past each end of a section. Once placed horizontally the sections were joined with the bars of the adjoining section. The open joints were then concreted using a cement gun to fill the space and acquire a strong bond.⁹²

The only sections that differed in construction techniques were the bow and stern sections. The stern section was built in the launching ways using fixed forms. The bow had a different shape but otherwise followed the same construction methods as the other sections that were added to the stern; it was the last section to be added to the ship.

⁹⁰ Ralph Howard, "A Daring Ship Design," *Scientific American*, CXXIV, No. 4 (January 1921), 68.

⁹¹ "Rebuilding Aransas Pass after the 1919 hurricane part of Kelley career," *The Aransas Pass Progress*, 23 September 1970.

⁹² Ralph Howard, "A Daring Ship Design," *Scientific American*, CXXIV, No. 4 (January 1921), 68.

In order to help make the ships more economically viable, they needed to lighten the ship from the traditional 150 pounds (68.04kg) per cubic foot of ordinary concrete down to a weight of 110 pounds (49.9 kg) per cubic foot. This was achieved using a



Figure 11. Section of Aransas Pass concrete ship being shifted to a horizontal position. Reprinted from *Scientific American*.⁹³

mixture of one-part crushed coke, ½ inch (1.27 cm) and smaller to one-part cement.⁹⁴ This did not include the weight of the reinforcement. There were other aspects of the design that affected weight as well. First, due to the cylindrical design, there was no transverse framing and to compensate the concrete was poured to a thickness of ten

⁹³ Ralph Howard, "A Daring Ship Design," *Scientific American*, CXXIV, No. 4 (January 1921), 79.

⁹⁴ *Ibid.*

inches (25.4 cm) at the bottom and seven inches (17.78 cm) at the top. This is a drastic difference from the Emergency Fleet Corporation shipyards that were building concrete ships over 400 feet (121.92m) in length with concrete that was only four to five inches (10.16 to 12.7cm) thick.

Of the two ships built in Port Aransas, only *Durham* was ever fully outfitted. For propulsion, *Durham* was equipped with a twin-screw diesel engine imported from Sweden powered by fuel oil, but the weight of the hull was more than the engine could handle.⁹⁵ The second ship, *Darlington*, was supposed to be fitted with similar engine, but it was never finished beyond the hull.

There were many challenges for the creation of these ships. A new shipyard had to be built, there was a shortage of housing for the men working in the shipyard, and a hurricane in 1919 delayed construction. Like the E.F.C. ships, they were not finished until after the end of the war, but more significantly they functioned extremely ineffectively as ships due to being underpowered and very poor sailors.⁹⁶

Conclusion

There is much that can be said about the construction of concrete ships in World War I. It was a time of great innovation and experimentation, but the knowledge base was limited. Concrete was seen as the ship building material of the future by its

⁹⁵ "Concrete Tanker Strands on Beach: Uncompleted Vessel from Port Aransas Aground at Pass Cavallo," *The Galveston Daily News*, 21 June 1922.

⁹⁶ Letter from Bedwell to Castlenboaldt, Rosenberg Library, Galveston and Texas History Center, Vertical Files D, Circa 1880-2018, Durham (Concrete ship), 14 July, 2018.

proponents. The people who supported its use in World War I were convinced that shipbuilding knowledge and trends had simply not caught up with the concept. While great strides were made in the designs and building techniques for these ships, their lack of employment (and hence the lack of testing) after World War I limited their future appeal. In a shipping environment that was oversaturated with ships, slower concrete vessels had a hard time competing. Five of the EFC ships became storage facilities once their shipping days were done, but this was hardly the future envisioned by their designers and builders.⁹⁷

From an economic standpoint, concrete did not perform as hoped, but developments in concrete construction suffered from supply shortages during the war and a surplus of steel and wood ships following the war.⁹⁸ Some of the promised benefits were there, but concrete ships lacked tonnage and speed. For all of the innovations that were made in concrete hull production during this time, they were allowed to stagnate until the start of World War II when a quick to construct, cheap shipping vessel was once again in demand.⁹⁹

⁹⁷ See Appendix A for an accounting of the other concrete ships from World War I.

⁹⁸ N.K. Fougner, *Seagoing and other concrete ships* (London, 1922), 105.

⁹⁹ See Appendix C for a brief history of World War II concrete vessels.

CHAPTER IV

VISUAL SURVEY OF SS *SELMA*

Selma has been in the same location for nearly a century, being continuously exposed to the wind, waves, and occasional storms. Although it has remained stationary, over the past decade *Selma* has suffered noticeable changes to its appearance. Few sections of the ship that have not been drastically affected by the environment. A better understanding of how *Selma*'s condition has changed over time may be obtained by examining four sets of photos. The photos groups range from early (probably from the second quarter of the nineteenth-century) undated images, photos from 2007, from 2012, and from 2018.

Circa 1940-1960

The first set of photos are not dated, in black and white, were likely taken sometime between 1940 and 1960. While all of these photos are from the General Photograph collection at the Corpus Christi Public Library, they are not necessarily all taken at the same time or by the same person. They show a ship that is clearly damaged (there are a few holes in the deck), but a substantial portion of the upper structure remains. The area with the greatest amount of damage appears to be the amidships superstructure.



Figure 12. Deck of *Selma* facing aft. Reprinted with permission of Corpus Christi Public Libraries .¹⁰⁰

Figure 12 was taken from just behind the foredeck looking aft on the port side. The deck is in relatively good shape, but the tops of the hatches are showing signs of deterioration. The concrete in these areas still appears to be in good condition with only a few areas where there might be the reinforcing steel showing. In much worse condition than the deck, the superstructure amidships (where the bridge was located) is still standing, but the bulkheads have chunks missing around the doorways and the reinforcing steel is visible.

¹⁰⁰ Corpus Christi Public Libraries Archive, General Photograph Collection, Collection F1 Box 18 Folder 18.04, 14 August, 2018.



Figure 13. Stern deck of *Selma* from amidships. Reprinted with permission of Corpus Christi Public Libraries .¹⁰¹

The condition of the deck is very hard to determine in Figure 13, since there is a large amount of debris covering it. It seems to be in decent condition as the reinforcing steel is not obviously exposed. The clearest area of deterioration is the remainder of rail that once encompassed the stern of the ship.

¹⁰¹ Corpus Christi Public Libraries Archive, General Photograph Collection, Collection F1 Box 18 Folder 18.04, 14 August, 2018.



Figure 14. Stern deck of *Selma*. Reprinted with permission of Corpus Christi Public Libraries.¹⁰²

Figure 14 of the stern shows a grimmer image than the previous ones. The deck in the stern is in much worse condition than the forward deck. This section of the deck has almost no portion that is not damaged, with both holes and visible steel reinforcement. There are two sets of bollards visible, both with tops broken off, but the two chocks still appear to be in working order.

¹⁰² Corpus Christi Public Libraries Archive, General Photograph Collection, Collection F1 Box 18 Folder 18.04, 14 August, 2018.



Figure 15. Deck of *Selma*, view aft. Reprinted with permission of Corpus Christi Public Libraries.¹⁰³

In this image of the starboard side (Figure 15), the deck is in much worse condition than on the port side. The reinforcing steel is showing though almost everywhere and there is a large hole in the deck exposing five beams. Interestingly, the starboard side of the upper structure is in much better shape than the port. Only one section of concrete is missing and almost none of the reinforcing steel is visible in this area.

¹⁰³ Corpus Christi Public Libraries Archive, General Photograph Collection, Collection F1 Box 18 Folder 18.04, 14 August, 2018.



Figure 16. Inside *Selma* superstructure. Reprinted with permission of Corpus Christi Public Libraries.¹⁰⁴

Figure 16 shows a considerable amount of damage within the central superstructure. A section of the deck is missing, part of the bulkhead is gone, and reinforcing steel is visible. This is the area above the engine room, and it is possible the damage occurred when fittings were removed prior to scuttling. There was also damage

¹⁰⁴ Corpus Christi Public Libraries Archive, General Photograph Collection, Collection F1 Box 18 Folder 18.04, 14 August, 2018.

caused by vandalism. We know this area was damaged by vandalism in 1928 (the local paper asked for information on the vandals who destroyed deckhouses on *Selma*).¹⁰⁵

2007

The second collection of photos date to 2007, around a year before Hurricane Ike swept through Galveston. Taken from a boat, these photos present a different perspective from the previous images, capturing the outer hull in detail.



Figure17. View of *Selma* from port side, 2007. Reprinted with permission of Amy Borgens.¹⁰⁶

The hull clearly shown in Figure 17 shows extensive erosion and collapse from water and wave action. The degradation of the metal is also quite obvious with rust stains running down the hull under the metal inserts. *Selma* is going to pieces.

¹⁰⁵ “Notices,” *The Galveston Daily News*, 25 July 1928.

¹⁰⁶ Amy Borgens, Personal Communication, 7 July 2018.



Figure 18. View of *Selma* amidships from starboard with partial view of lower foredeck, 2007. Reprinted with permission of Amy Borgens.¹⁰⁷



Figure 19. View of *Selma* amidships from starboard, 2007. Reprinted with permission of Amy Borgens.¹⁰⁸

¹⁰⁷ Amy Borgens, Personal Communication, 7 July 2018.

¹⁰⁸ Ibid.



Figure 20. *Selma* amidships, view aft, 2007. Reprinted with permission of Amy Borgens.¹⁰⁹

Figures 18, 19, and 20 show the amidships superstructure. In the earlier photos, this section of *Selma* had fully standing walls with missing sections of concrete. Here, the upper supports have fallen with the fore and aft bulkheads mostly gone. The port and starboard sides still survive with small pieces missing. The side of the ship is stained by rust a discoloration by the seawater and is further deteriorating from where the deck meets the side of the hull.



Figure 21. View of *Selma* from starboard stern, 2007. Reprinted with permission of Amy Borgens.¹¹⁰

¹⁰⁹ Amy Borgens, Personal Communication, 7 July 2018.

¹¹⁰ Ibid.

Figure 21 shows definite wear as compared to the 1940s-60s photos. The railing feature on the stern port side has only one support standing with the rest reduced to short stumps. The chock on the starboard side is damaged with only one small portion attached to the base. The bollards seen in Figures 14 and 15 on the starboard side are no longer there.



Figure 22. *Selma* from the stern, 2007. Reprinted with permission of Amy Borgens.¹¹¹

Figure 22 highlights the same areas as the previous photos, but shows additional details. The deck is clearly in worse shape than in the earlier photos. The back deck is

¹¹¹ Amy Borgens, Personal Communication, 7 July 2018.

now in direct contact with the water, which was not the case in the earlier photos. This suggests the stern has settled in the intervening decades. The base of the bollards can be seen in this photo and it is clear that only a few inches of the shafts remain. The upper beams of the central island are being held up by the outer walls, with none of the inner supports still standing. This view also shows the bulkhead below the foredeck, which has worn around the doorways.



Figure 23. *Selma* from port side, 2007. Reprinted with permission of Amy Borgens.¹¹²

Figure 23 shows the port side of the bow, with the area above the water in poor condition. The steel reinforcing is exposed and there are multiple holes in the side. The

¹¹² Amy Borgens, Personal Communication, 7 July 2018.

condition of the deck is hard to gauge, but reinforcing steel is exposed. The hatches in Figure 23 look more deteriorated than the aft hatches that can be seen in Figure 23. The metal bands are missing sections and some of the hatches have concrete missing on their sides. The concrete and metal pieces of the raised foredeck appear to be in better condition than those on the main deck.



Figure 24. *Selma*, bow from port side 2007. Reprinted with permission of Amy Borgens.¹¹³

Figure 24 shows the aft bulkhead of the foredeck. The condition of the concrete above the wave action is still good. The metal bollards and chocks on the raised foredeck are in much better condition than those on the main deck.

¹¹³ Amy Borgens, Personal Communication, 7 July 2018.



Figure 25. Close up of *Selma* name port, 2007. Reprinted with permission of Amy Borgens.¹¹⁴



Figure 26. Close up of *Selma* name starboard, 2007. Reprinted with permission of Amy Borgens.¹¹⁵

In Figures 25 and 26 ‘ELMA’ is still readable on the port side and ‘ELM’ still readable on the starboard side. An image facing the bow of the ship (Figure 27) provides

¹¹⁴ Amy Borgens, Personal Communication, 7 July 2018.

¹¹⁵ Ibid.

a good position to see how regular contact with the water has deteriorated the lower hull of *Selma*.



Figure 27. *Selma*, viewed from bow, 2007. Reprinted with permission of Amy Borgens.¹¹⁶

2012

The third series of photos date from 2012 and once again were taken from a boat. There is more exposed reinforcement but the ship shows little change over the five-year period, even after surviving another large hurricane, Ike in 2008. The areas most affected by the passage of time were also the areas that had the most damage previously.

¹¹⁶ Amy Borgens, Personal Communication, 7 July 2018.



Figure 28. *Selma* viewed from bow, 2012.¹¹⁷

Overall, the fore of *Selma* looks remarkably unchanged from the 2007 to 2012 photo. The main difference is on the port hawsepiper bolster plate, where the upper corner is now missing. The area affected by the wave action still seems to be at approximately the same height. From this angle there are no obvious major changes in the condition of *Selma*.

¹¹⁷ Photo by Dorothy Rowland.



Figure 29. Views of ship's name from starboard, 2012.¹¹⁸

The image of the ship's name in Figure 29 looks very similar to Figure 28, but only 'EL' is still visible. The reinforcing steel also appears to be in much worse condition with the rust much more apparent.

¹¹⁸ Photo by Dorothy Rowland.



Figure 30. View of *Selma* bow from port side, 2012.¹¹⁹

There is no direct comparison photo from 2007, but Figure 30 shows the significant deterioration of the concrete on the starboard side with many large holes visible. It is noteworthy that there is a hole extending through the entire ship.



Figure 31. View of *Selma* amidships port side, 2012.¹²⁰

¹¹⁹ Photo by Dorothy Rowland.

¹²⁰ Ibid.

Figure 31 shows a significant change in the condition of *Selma* amidships. In the earliest photos (see Figures 12, 15, and 16) the side of the island superstructure was largely intact to its upper support beams. In 2007, the sides were still standing with some sections of concrete missing and the forward and after bulkheads largely gone. In 2012, the walls are clearly falling apart with large holes riddling the structure.

2018

The final collection of photos is from 2018, approximately six months after hurricane Harvey. These photos show some changes when compared to the 2012 photos, most of them in areas that already showed serious damage. What is most surprising about the 2018 photos is that there are still parts of the ship that look only moderately affected by time and the environment.



Figure 32. View of *Selma* from stern, 2018.¹²¹

¹²¹ Photo by Dorothy Rowland.



Figure 33. View of *Selma* stern to amidships from the port side, 2018.¹²²

Figure 32 shows the good and the bad. The raised foredeck still appears to be holding together, but the rest of *Selma* looks more like what would be expected from a ship that has been sitting in the water for ninety-six years. As seen in the 2012 photos, the stern of the ship is settling further under the water. There is more of the reinforcing steel showing and the opening in the foredeck bulkhead has gotten larger.

As seen in both Figures 32 and 33, there is still one remaining piece of stern railing standing, although it is looking less sturdy than in earlier photos. The hatch coamings are also showing significant wear with almost all missing concrete around the top. The stern of *Selma* is clearly affected by its contact with the water.

¹²² Photo by Dorothy Rowland



Figure 34. View of *Selma* from port side of stern, 2018.¹²³



Figure 35. View of *Selma* just forward of amidships looking to the bow, 2018.¹²⁴

¹²³ Photo by Dorothy Rowland.

¹²⁴ Photo by Dorothy Rowland.

Different from the 2007 photos, the area of *Selma* afterdeck exposed to wave action has increased. It is likely that the action of currents (and storms as well) are causing the stern end of the ship to dig its way further into the sediment below.

Figure 35 shows the port side concrete erosion and the extent to which the steel reinforcing rods are becoming exposed to the elements. The few sections of the superstructure still standing are beginning to fall and the holes in the raised foredeck bulkhead are expanding.



Figure 36. View of the bow of *Selma* from the port, 2018.¹²⁵

¹²⁵ Photo by Dorothy Rowland

Figure 36 shows how, from 2012 to 2018, the holes in the port side of *Selma*'s bow have become much larger. The metal insert for the fore-mast, which in Figures 22 and 23 was in the middle of the deck just forward of the superstructure, is now located on the port side abaft the foredeck bulkhead. It seems unlikely that wave action could have moved the metal piece up the deck, and it is more likely that this was done by humans rather than waves.



Figure 37. Close up a chock and section of the port side hull on *Selma*, 2018.¹²⁶

¹²⁶ Photo by Dorothy Rowland.

Figure 37 shows how the steel reinforcement is damaging the concrete from the inside due to expansive forces of iron corrosion causing the concrete to spall off the sides and deck. The outside of the concrete that still has the outer layer looks like it is in fairly good condition, but there is staining from the steel rods deteriorating underneath the surface.



Figure 38. View of *Selma*, amidships deck, 2018.¹²⁷

¹²⁷ Photo by Dorothy Rowland.



Figure 39. Close up of concrete on *Selma*, 2018.¹²⁸

Figure 38 shows the large holes in the deteriorated deck. The original surface of the concrete is gone. The metal deck fittings in this photo are also in poor condition with the bollards posts missing their upper ends.

Figure 39 indicates that in a few places the original surface of the concrete has survived, complete with impressions of the planks that formed the construction molds. In all of these images we can see that the deterioration of the steel inside the concrete is damaging the integrity of the hull as much or more than the actions of outside wave and currents.

¹²⁸ Ibid.



Figure 40. View of the bow of *Selma*, 2018.¹²⁹

As expected, the condition of *Selma* has deteriorated greatly over time, with the stern degrading at the fastest rate and the bow holding up longer (Figure 40). The ship has been exposed to many deteriorating factors such as storms, waves, currents, salt water, vandalism, and particularly the effects of iron corrosion causing the concrete to spall and check. The rate of degradation of *Selma* does not appear to be changing too much, but the areas with issues are only increasing. It is a large mass of concrete and steel, however, and even in its deteriorated condition, *Selma* will continue to be a landmark in Galveston Bay for many years to come.

¹²⁹ Photo by Dorothy Rowland.

CHAPTER V

CONCLUSION

Concrete was briefly considered to be one answer to the merchant ship shortage in World War I. The United States was only formally engaged in the war for one year and seven months, however, and in this short span the E.F.C. shipping program was unable to articulate the quick construction needed to truly make a difference. The concrete ships of World War I represent an important aspect of United States maritime history but are often overlooked due to their limited contribution to the war effort and unlikely nature. The unique construction of these ships shows a combination of ingenuity and shortages that the war created. While concrete-hulled ships did not become a viable investment for everyday shipping, building with concrete is uniquely suited to wartime when scarcities of manpower and supplies created opportunities for non-traditional approaches to meet demands. Sir Owen Williams, who designed Britain's concrete ships in World War II, perhaps said it best: "I do not suggest that all-concrete ships will ever replace steel ones, but it is certain that there is a real place for them in wartime."¹³⁰

The concrete shipwrecks in the Galveston, Texas area represent two different construction techniques and approaches to the challenge of quickly and cheaply making oil tankers from concrete. Unfortunately, both methods of construction fell short of expectations. The E.F.C. ships were not produced in the projected quick timeline, and

¹³⁰ Gainor W. Jackson, Jr and W. Morley Sutherland, *Concrete Boatbuilding* (London, 1969), 97.

the Aransas Pass vessels lacked seaworthiness. Even with these drawbacks, the experimental use of concrete as a shipbuilding material provided technological advances to concrete construction in general and in the long term provided useful information on the durability of concrete in maritime environments.

Due to the limitations of concrete, it seems unlikely that it will ever become the standard material for building seagoing ships. Concrete is not used for today's large merchant ships, but it is still present in maritime construction and shipbuilding. Ferrocement has been used in the past to create sailboats and was a popular do-it-yourself option in the 1960s and 1970s. It was also used for a range of smaller craft from fishing trawlers to yachts. Where concrete has proved more useful is in the production of non-seagoing vessels. Barges and docks are common industrial maritime structures that use concrete on a large scale. While it is unlikely that any large concrete ships are going to be used in the near future, the development of new concrete uses in the maritime setting will no doubt continue.

Selma, Durham, and other World War I-era concrete ship did not create a demand during their use in the post war era, but their impact was significant. *Selma* has lived on beyond its abandonment, with a rich legacy of local history from many stories and legends arising since it was scuttled. To this day, *Selma* is still a popular fishing spot and a monument in the bay to a history that many have been forgotten. The other two concrete ships off of Bolivar peninsula are also a popular fishing spots and are mentioned on fishing site forums relating to the area. These ships are an important part of both the United States and Galveston, Texas history.

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APPENDIX A
OTHER UNITED STATES SHIPPING BOARDS
CONCRETE SHIPS OF WORLD WAR I

Polias – Experimental concrete ship built by the Fougner Concrete Shipbuilding Co. in North Beach, Flushing Bay, New York. With a gross weight of 2,564 tons, *Polias* was launched on 22 May 1919.

Atlantus – Experimental concrete ship built by the Liberty Shipbuilding Co. in Brunswick, Georgia. *Atlantus* had a gross weight of 2,391 tons and launched on 4 December 1918.

Cape Fear – Sister ship of *Sapona*, built by the Liberty Shipbuilding Co. in Wilmington, North Carolina. One of the 3,500 deadweight ships, *Cape Fear* was launched 31 July 1919.

Sapona – Sister ship of *Cape Fear*, built by the Liberty Shipbuilding Co. in Wilmington, North Carolina. *Sapona* was a 3,500 deadweight ship and was launched 11 October 1919.

Latham – Sister ship of *Selma* built by Fred T. Lay and Co. in Mobile, Alabama. *Latham* was a 7,500 deadweight type.

Cuyamaca – A 7500 deadweight type, *Cuyamaca* was built by the Pacific Marine Construction Company and launched in San Diego, California on 15 September 1920. Its sister ship was the *San Pasqual*. It was used as an oil carrier and then as floating oil storage. The ship was finally dismantled in 1924.

San Pasqual – Sister ship to the *Cuyamaca*, it was built by the Pacific Marine Construction Company in San Diego, California. Launched on 28 June 1920, *San Pasqual* was another 7,500 deadweight type ship. It was used for a short time as an oil tanker, but after being damaged in a storm was used as a storage ship in Cuba.¹³¹

Palo Alto – Registered on 23 October 1920 in San Francisco, California *Palo Alto* was offered for sale upon completion. A sale in the works for this ship and its sister ship *Peralta*, but it did not appear to go through as the ships were instead laid up in San Francisco. In 1924, *Palo Alto* was sold for \$18,750 and dismantled. In 1930 she was turned into a fishing pier in Monterey Bay.

Peralta – Registered around the same time as *Palo Alto*, *Peralta*, also built in San Francisco, California and was laid up until also being sold in 1924 for \$15,000. The hull was stripped of machinery and sold for use as a fish reduction plant in Alaska. In 1932, it was moved back down to California for use as a fish reduction plant for sardines. Following this use it was moored until being sold to be a floating breakwater in Canada.

Dinsmore – Built in Jacksonville, Florida and registered on 5 March 1921, *Dinsmore* made one voyage to Mobile, Alabama. In Mobile, the vessel was used as an oil storage tanker until 1932. In 1935 *Dinsmore* was sunk as a breakwater off of Texas, but the exact location is unknown.

¹³¹ Robert Eberhardt. "Concrete Shipbuilding in San Diego, 1918-1920," *The Journal of San Diego History*, XLI (Spring 1995).

Moffitt – Sister ship of *Dinsmore*, also built in Jacksonville, Florida, *Moffitt* was registered on 13 April 1921. It made one trip to Mobile where it was then laid up until 1924 when the machinery was removed. It was then sold for use as a barge.¹³²

¹³² Jean Haviland, “American Concrete Steamers of the First and Second World Wars,” *American Neptune*, XX (July 1962).

APPENDIX B
CONSTRUCTION SEQUENCE
(AS EMPLOYED DURING WORLD WAR I)

The Lead Engineer R.J. Wig described the construction sequence for World War I-era concrete ships in a 1919 paper for the *Society of Naval Architects and Marine Engineers* as:

1. The underpinning or blocking for supporting the floor forms is set in position on the ways.
2. The scaffolding with overhead trusses for holding the outside forms is set in position.
3. The outside bottom and side forms were erected complete, thus providing means for supporting the reinforcing steel.
4. All steel inserts such as sea chests, stern frame, stem plate, hawse pipes, etc., are secured in place on the inside of the outside forms.
5. The bottom and side shell reinforcing steel is placed within the outside forms.
6. The bottom and side frame steel and the keelson reinforcing steel is erected. Splice bars between the bulkheads and shell are placed in position.
7. The inside frame, keelson and side shell forms are erected to the height of 4 or 5 feet.
8. Concrete is placed in the keelsons and in the bottom and sides of shell and frames up to the 4 or 5 foot draught line.
9. Bottom inside forms are removed and the concrete is pointed up where necessary. Top surface of concrete, where it will join the succeeding pour of concrete, is thoroughly cleaned and roughened.
10. The erection of the frame and bulkhead steel is continued up to the elevation of the second deck.
11. The inside frame, bulkhead and shell forms are erected up to the second deck.
12. Inserts for pipes, equipment, etc., in frames and bulkheads are set in place.
13. Concrete is placed up on the underside of the second deck.

14. The inside forms are removed from the frames and bulkheads, the concrete is pointed, and the upper surface which makes a joint with the next lift is cleaned and roughened.
15. Forms for the second deck beams and slab are placed, supported on inside staging and props from the concrete keelsons and frames.
16. Inserts for equipment and pipes in the second deck are placed.
17. The reinforcing steel in the second deck is placed.
18. The concrete is placed in the slab and beams of the second deck.
19. The inside frame and bulkhead reinforcing steel is erected to the top deck.
20. The inside shell, bulkhead and frame forms are erected to the top deck.
21. Inserts for equipment and pipes in frames and bulkheads between the second and top decks are placed.
22. Concrete is placed in the shell, bulkheads, and frames to the under side of the fillet at the top deck.
23. The upper surface of the concrete which makes a joint with the next pour is cleaned and roughened.
24. The top deck beams and slab forms are placed.
25. The deck inserts for equipment, pipes, etc., are placed.
26. The longitudinal reinforcing steel is placed in the fillet at the top deck and in the deck beams and slab.
27. Concrete is placed in the top deck fillet, the deck beams and the deck slab.
28. The reinforcing steel is placed in the hatch coamings, bulwarks and deck erections.
29. The forms are placed for hatch coamings, bulwarks, and deck erections.
30. The concrete is placed in all deck erections.
31. All the remaining inside forms and staging are removed and all interior surfaces of the concrete are cleaned and pointed. All outside forms on the sides and bottom of the hull are removed, and the concrete is cleaned and pointed where defective.
32. All tanks are tested up to the light draught line and pointing and patching of concrete is done if found necessary after testing.
33. The exterior and, if time permits before launching, the interior surfaces of the concrete are painted.
34. The launching ways are placed in position under the hull, the blocking is changed, and the hull is launched.¹³³

¹³³ R.J. Wig, Esq., "Method of Construction of Concrete Ships," *Society of Naval Architects and Marine Engineers*, XXVII (November 1919), 2-3.

APPENDIX C

WORLD WAR II CONCRETE SHIPS

With the start of World War II, increasing the shipping tonnage once again became a necessity. As with World War I, steel became difficult to obtain, so concrete was again chosen as a secondary building material. The concrete building program originally was limited to barges, but expanded to include self-propelled vessels in 1942 when twenty-four were contracted to McCloskey and Co. of Philadelphia.

The concrete used for the World War II ships was slightly heavier at around 115 pounds (52 kg) per cubic foot when compared to the E.F.C. ships of World War I. While the concrete mix was slightly different, the construction method was very similar. The ships were poured from the bottom in vertical sections. The slightly more robust concrete was an improvement to the ships as three of the vessels weathered hurricanes without being seriously damaged.

The ships were launched in groups of three starting in July 1943 and finishing in September 1944. Unlike the World War I ships, all of the contracted ships were finished. This was helped by the more realistic number contracted and the use of a single company. The ships were used in both the Pacific and Atlantic theatres, with many in the Pacific being used as store ships. Two of the first ships launched were damaged during

their launches, quickly removed from service, and subsequently sunk as breakwaters off Normandy.¹³⁴

The concrete shipbuilding program of World War II took advantage of lessons from the previous attempt. As with the World War I concrete ships, these vessels had varying levels of success, but overall those launched during World War II had greater success. All of the vessels in the World War II program were launched before the end of the war, fifteen of them ended up as breakwaters, while the rest were sunk or wrecked. Overall, the later vessels appear to have been built sturdier and they certainly performed better.

¹³⁴ Jean Haviland, "American Concrete Steamers of the First and Second World Wars," *American Neptune*, XX (July 1962), 176.